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WATER SUPPLY AND WATER QUALITY CONTROL STUDY, LOUISVILLE RESERVOIR, HELM RESERVOIR, WABASH RIVER BASIN, ILLINOIS

Federal Water Pollution Control
Administration
Evansville, Indiana

December 1965

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WATER SUPPLY AND WATER QUALITY CONTROL STUDY LOUISVILLE RESERVOIR HELM RESERVOIR WABASH RIVER BASIN ILLINOIS

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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE, REGION III
CHARLOTTESVILLE, VIRGINIA
DECEMBER 1965

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WATER SUPPLY AND WATER QUALITY CONTROL STUDY
LOUISVILLE RESERVOIR AND HELM RESERVOIR
WABASH RIVER BASIN
ILLINOIS

Abstract

A study has been made which discloses a need for storage in the proposed reservoirs for municipal water supply and for water quality control. These conclusions are based on analysis of existing water quality information and hydrologic, economic, and demographic analyses. Future needs are projected to the year 2020.

Prepared at the request of the District Engineer
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
Corps of Engineers
Louisville, Kentucky

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region III
Ohio River Basin Project
Evansville Field Station, Indiana

December 1965

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I. INTRODUCTION

Request and Authority

The Corps of Engineers, Louisville District, is preparing a comprehensive study of the Wabash River Basin concerning the development of water and related land resources. This study, as outlined in the "Plan of Survey, Wabash River Basin," September 23, 1963 (revised May 1964), requests the Public Health Service to determine present and future needs for and value of storage for municipal and industrial water supply and for regulation of streamflow for the purpose of water quality control.

This study has been made in accordance with the Memorandum of Agreement dated November 4, 1958, between the Department of the Army and the Department of Health, Education, and Welfare, relative to the Water Supply Act of 1958 as amended (43 U.S.C. 390b) and the Federal Water Pollution Control Act as amended (33 U.S.C. 466 et seq.).

Purpose and Scope

The purpose of this study is to determine the need for and value of storage in the Louisville and Helm Reservoirs for the purposes of municipal and industrial water supply and water quality control in the Little Wabash River Basin. The multiple-purpose projects under study are located on the Little Wabash River and on Skillet Fork, a tributary to the Little Wabash River.

The period of study for this report is from the present to the year 2020. This is the period for which the economic guidelines were established by the Corps of Engineers Ohio River Division "Projective Economic Study of the Ohio River Basin" and consequent economic studies of the Wabash River Basin.

The area studied includes 15 counties in southeastern Illinois approximately 100 miles east of St. Louis, Missouri.

Acknowledgments

Completion of this study was made possible by the cooperation and assistance of Federal and State authorities and by local authorities in the basin. Information and data were furnished from their publications, records, and files.

Acknowledgment is made of the assistance given by the following agencies:

U. S. Army Engineer District - Louisville, Kentucky

U. S. Geological Survey - Champaign, Illinois

U. S. Soil Conservation Service - Indianapolis, Indiana

U. S. Fish and Wildlife Service, Division of Sport Fisheries and Wildlife - Lebanon, Ohio

U. S. Federal Power Commission - Chicago, Illinois

Illinois Department of Public Health, Division of Sanitary Engineering

Illinois Department of Public Works and Buildings, Division of Waterways

Illinois Department of Registration and Education, Illinois Geological Survey

Illinois Department of Registration and Education, Illinois Water Survey

Illinois Department of Mines and Minerals, Division of Gas and Oil Conservation

Illinois Department of Business and Economic Development

Illinois Department of Conservation, Division of Fisheries

II. SUMMARY OF FINDINGS AND CONCLUSIONS

Summary of Findings

1. The U. S. Army Corps of Engineers is conducting a feasibility study of two reservoirs in the Little Wabash River Basin, Illinois, a tributary to the Wabash River. These are the Louisville Reservoir, 3.5 miles northwest of Louisville, Illinois, in Clay County on the Little Wabash River, and the Helm Reservoir, two miles northwest of Helm, Illinois, in Marion County on Skillet Fork, a tributary of the Little Wabash River.

2. The area studied by the U. S. Public Health Service* in determining needs for water supply and quality control water from these two proposed structures is the Little Wabash River Basin in southeast Illinois. The total drainage area is 3,320 square miles and includes all or parts of 13 counties.

3. Poor low flow characteristics are typical throughout the basin. Minimum flows of zero have been recorded at both upstream U. S. Geological Survey gaging stations at Clay City on the Little Wabash River and at Wayne City on Skillet Fork. The minimum recorded daily flow at Carmi with a drainage area of 3,111 square miles is only 0.6 cubic feet per second (cfs).

4. The 1960 population in the economic study area was 208,000; of whom 84,000 lived in urban areas. The engineering study area includes 57,000 of the 84,000 people living in urban areas.

*The Federal Water Pollution Control Administration took over this function of the U. S. Public Health Service on December 31, 1965.

5. For the engineering study area, the total present use from municipal water supplies is 8.33 million gallons per day (mgd). This is equivalent to 105 gallons per capita per day (gpcd) for the public water users. The range in use observed for communities in this basin is from 19 to 208 gpcd.

6. All major communities in the basin have secondary waste treatment plants and all industries studied use municipal waste treatment facilities. Eighty-five percent removal of 5-day biochemical oxygen demand (BOD) loadings is effected in these plants.

7. Brine and oil from oil field wastes, agricultural wastes, and natural organic wastes (primarily decaying leaves and logs) are the major sources of added pollutants entering the streams. The basinwide ranges of a few mineral constituents naturally present in the water are listed here in mg/l.

	Surface Water		Ground Water	
	Low	High	Low	High
Manganese	0.0	1.4	0.0	0.3
Iron	0.2	17.7	0.0	3.8
Total Dissolved Solids	70	2,080	294	1,330
Total Hardness	38	391	127	558

Surface and ground water quality is considered as fair.

Conclusions

1. In the year 1980, the total population in the economic study area is expected to approach 238,000. Of these, 112,000 are anticipated to be urban dwellers. Of these urban dwellers, 86,000 are expected to reside in the engineering study area. In the year 2020, the total population anticipated in the economic study area is 418,000. The number of urban dwellers in the economic study area is estimated to be 215,000, while the number of urban dwellers in the engineering study area is anticipated to be 179,000.

2. In the year 1980, water use for water supply is projected to reach 14.5 mgd and by the year 2020 is projected to be 36.1 mgd.

3. A water need will exist in the stream reach that includes the communities of Flora, Xenia, and Clay City by the year 1970. Flow levels of 1.1 mgd and 3.3 mgd in the years 1980 and 2020, respectively, are estimated to be needed to meet water supply demands.

The remaining communities in the basin, which will have a water supply need, are not located sufficiently near the water supplied from these proposed reservoirs to economically utilize storage in them.

4. To provide for water quality control through streamflow regulation in the Skillet Fork and Little Wabash River reaches below the proposed Helm and Louisville damsites through the year 2020 will require an annual draft-on-storage* of 12,200 acre-feet in the basin.

*Annual draft-on-storage is the sum of the incremental excesses of the needed releases over inflows during a climatic year, i.e., from April of one year to March of the following year.

Of this total draft-on-storage need, 9,000 acre-feet are needed in the Louisville Reservoir and 3,200 acre-feet are needed in the Helm Reservoir.

5. The flows assured by a draft-on-storage of 12,200 acre-feet will maintain 5 mg/l dissolved oxygen below the proposed reservoirs during an expected one in ten year recurrence interval drought except in a portion of a reach of stream impounded by Carmi for water supply. The water quality for water supply purposes will not be adversely affected by failure to meet this criterion in this impounded reach.

6. The minimum annual value of benefits of providing water for water supply in the Louisville Reservoir for the communities of Flora, Xenia, and Clay City is $2,100. The minimum annual value of water quality benefits to be derived from storage in the Louisville and Helm Reservoirs are $114,000 and $32,000 respectively. The values used are based on the least costly alternatives to the Louisville and Helm projects studies to provide water for water supply and adequate water quality for the basin. The value of these annual benefits, including operation and maintenance costs, are based on a 100-year amortization of capital costs at an interest rate of 3 1/8 percent.

7. Benefits to accrue by providing storage for water supply and/or quality control are increased land values, increased and expanded industry, increased recreation, and maintenance of high standards of public health.

8. Thermal stratification may be expected to occur in the Louisville and Helm Reservoirs with reduction of dissolved oxygen in the hypolimnion. To assure discharge of good quality water below the dam, it is recommended that openings be provided at a minimum of three levels to make possible selection of the best quality water available.

9. These streamflow needs and the value of benefits are based on the best estimate that can be made at this time and are subject to review and revision based on information and data from the Ohio River Comprehensive Study by the Department of Health, Education, and Welfare when it becomes available.

III. PROJECT DESCRIPTION

Location

This report considers two proposed reservoir sites in the Little Wabash River Basin which is located entirely within the State of Illinois. The Louisville Reservoir site is located 3.5 miles above the community of Louisville in Clay County on the Little Wabash River. The Helm Reservoir site on Skillet Fork is about 15 miles northwest of the community of Wayne City in Marion County. See Figure I at the end of this report for the basin location map. (All figures appear in the Appendix.)

Streamflow

The U. S. Geological Survey gaging station located on the Little Wabash River at Clay City has experienced a mean flow of 894 cfs for a drainage area of 1,134 square miles.[1] The Louisville Reservoir site located upstream has a drainage area of 661[2] square miles and will control about one-third of the drainage area of the Little Wabash River excluding Skillet Fork.

The Helm Reservoir site has a drainage area of 210 square miles[3] or 20 percent of the drainage area of Skillet Fork. A U. S. Geological Survey gage at Wayne City downstream of the damsite has a drainage area of 464 square miles and a mean flow of 396 cfs.[1]

Water Quality

The proposed Louisville Reservoir site is located below the communities of Altamont and Effingham in an active oil field area. Algal growths will result where municipal and industrial wastes enter the upstream shallow fingers of the proposed reservoir. From data collected between 1950 and 1956 by the State of Illinois[4] at Clay City, the average chloride concentration in the reservoir is expected to approach 40 milligrams per liter (mg/l) with an average maximum concentration of 100 mg/l if present brine discharges are continued. Some fingers of the reservoir where brines are being actively released from oil fields can experience higher sporatic chloride concentrations and will be the most probable areas of oil slick occurrences. Existing State legislation on oil field management provides for control of these problems.[5]

Pertinent Data

The proposed Louisville Reservoir would, at maximum conservation pool elevation of 476 feet mean sea level (msl), provide a 41-foot depth of water at the damsite, a surface area of 7,750 acres, and a total storage volume of 84,000 acre-feet.[2] This pool elevation would back the reservoir up the Little Wabash River 15 miles in Clay and Effingham Counties to a point 8 miles below the city of Effingham.

Helm Reservoir, at maximum conservation pool elevation of 466 feet msl, would yield a 41-foot depth of water at the damsite, a surface area of 5,300 acres, and a total storage volume of 53,000 acre-feet.[3] At this

conservation pool elevation, the reservoir would be 11 miles long and lie entirely within Marion County. See Table III-1 for further pertinent data on these reservoir sites. (All tables appear in the Appendix.)

IV. STUDY AREA DESCRIPTION

Location and Boundaries

The engineering study area consists of the entire Little Wabash River Basin which is located in the southeastern section of the State of Illinois. It is the second largest tributary of the Wabash River draining an area of 3,320 square miles. The Little Wabash River has a long oval-shaped basin bounded on the north and west by the Kaskaskia River Basin, on the southwest by the Big Muddy River Basin, both tributaries to the Mississippi River; on the east by the Embarrass River Basin, on the southeast by the Bonpas Creek Basin, both tributaries to the Wabash River; and on the south by the Saline River Basin, a tributary to the Ohio River. The basin extends from the city of Mattoon, Illinois, which is approximately 70 miles east of Springfield, south to the community of New Haven about 30 miles west of Evansville, Indiana. All or portions of 13 counties are included in the drainage area of the Little Wabash River and listed from north to south are: Coles, Shelby, Cumberland, Effingham, Jasper, Clay, Marion, Richland, Jefferson, Wayne, Edwards, Hamilton, and White Counties. (See Figure I.)

Geography and Topography

The Little Wabash River begins in the terminal moraine of the Wisconsin Glacier. From its headwaters near Mattoon, the river flows southeastward and joins the Wabash River 2 miles southeast of New Haven

and about 13 miles above the confluence of the Wabash River and the Ohio River. The stream has an average fall of 0.6 feet per mile over its length of some 240 miles. The upper part of the basin consists of relatively level, semi-prairie type land drained by low-gradient tributaries, some being channelized to provide more efficient drainage. Proceeding southward the Little Wabash passes through a moderate gorge area with the adjacent areas drained by comparatively short tributary systems of steeper gradient as they near the main stream. In the lower reaches of the basin, the main stream passes through a broad flat valley with adjacent drainage areas rising to rolling and wooded uplands intermingled with isolated areas of prairie.[6]

Skillet Fork is the largest tributary to the Little Wabash River, having a drainage area of about 1,070 square miles or about one-third the drainage area of the entire basin. This stream originates in Marion County and flows southeastward past Wayne City, through extensive lowland areas subject to flooding, and on to the Little Wabash River 2.5 miles northeast of the city of Carmi in White County. Portions of its route have been channelized to facilitate a faster rate of runoff[6] and more work is contemplated in clearing and cleaning this stream below Wayne City to the Little Wabash River, funded partially by the Skillet Fork River Outlet Union Drainage District and partly by the State of Illinois.

The topography of the land in the Skillet Fork drainage basin is similar to the middle and lower portions of the Little Wabash drainage basin.

Climate

In general, the climate in the Little Wabash River Basin is temperate with a growing season of seven months. The mean annual temperature of the basin is approximately 56°F with a mean winter temperature of 35°F and a mean summer temperature of 77°F. The month with the highest mean temperature, 78°F, is July, and the month with the lowest mean temperature, 33°F, is January.

The average annual precipitation in the basin has been measured as follows: Effingham, in the northern part of the basin, 39.6 inches; and Mount Vernon, Indiana, just outside the southern tip of the basin, 42.5 inches.[7] The average annual precipitation for the entire basin is 41.6 inches. The area has suffered from sleet, hail, snow and ice storms, as well as from tornadoes characteristic of the Mississippi Valley.

Principal Communities and Industries

At present, the Little Wabash Basin is mostly rural with a total population in 1960 of less than 150,000 in an area of 3,320 square miles. Olney and Effingham are the largest cities in the basin with populations in excess of 8,000. Mattoon, located just north of the basin and drawing its water supply from the basin, has a population greater than 19,000. Carmi, Albion, Flora, and Fairfield, while smaller than the communities listed above, are significant population centers for this area.

Agriculture and oil production have been the chief employment sources in this area, but increased mechanization has caused this to decrease as a means of livelihood for a major segment of the basin's population. The population has shifted from the rural areas to the cities in the basin or out of the basin entirely. The cities have diversified light industry which the more active communities are trying to entice and keep to offset the employment decline in agriculture and mining. The light industry ranges from machinery production to textiles and leather goods.

V. WATER RESOURCES OF THE STUDY AREA

Quantity of Water Available

Surface Water

Zero flow has been recorded at both Wayne City below the proposed Helm Reservoir on Skillet Fork and Clay City below the proposed Louisville Reservoir on the Little Wabash River. The mean flows at these two gages are 396 cfs and 894 cfs respectively. In 24 years of record, the lowest flow recorded at Carmi on the Little Wabash River below the confluence of Skillet Fork and the Little Wabash River is only 0.6 cfs for one day and the mean flow is 2,557 cfs.[1] The minimum seven consecutive day mean flow with an expected ten years' recurrence is 4.0 cfs. The minimum one day once in thirty year mean flow expected is 0.45 cfs (see Table V-1).

During low flow years, over 47 percent of the annual flow at Carmi occurs during only two months, March and April (see Figure V). Similar values are experienced at Wayne City (see Figure VI) and Clay City (see Figure VII).

There are 13 single-purpose water supply reservoirs and low head impoundments in the basin (see Table VII-1). Except for the impoundment at Carmi, which backs water up the Little Wabash River and also up Skillet Fork decreasing the velocity of the streams in these affected reaches, the remaining impoundments do not significantly affect the flow in either Skillet Fork or the Little Wabash River.

Ground Water

Ground water aquifers capable of producing 500 gallons per minute (gpm) with proper development exist where sand and gravel deposits occur with other unconsolidated material deposited by preglacial rivers in the Little Wabash Basin. These generally follow the course of the present riverbed. Contiguous areas generally capable of producing between 50 and 200 gpm are considered as areas of fair to good ground water aquifers.

According to Illinois State Geological Survey Circulars 212, 225, and 248[8] (see Figure II), "the areas of good to excellent probability of sand and gravel aquifers are underlain by thick deposits of unconsolidated material containing sand and gravel. Ground water for domestic use may be easily obtained with small diameter drilled wells. The probability for construction of high capacity wells for municipal and industrial supplies is good, although test drilling is needed to locate the more permeable aquifers.

"The areas of fair to good are underlain by moderate thicknesses of unconsolidated materials filling minor valleys or bordering the main valleys and have some thin or discontinuous deposits of sand and gravel. Ground water for domestic and farm supplies is locally obtained in this area from drilled wells in sand and gravel, but in some places good water-yielding deposits are absent and wells are drilled into bedrock. The probabilities for obtaining supplies of ground water for municipal

and industrial purposes are poor to fair, and extensive geophysical and test-drilling explorations for sand and gravel deposits are necessary." (See Figure II.)

"The area labeled 'poor' is principally upland where glacial drift is thin or absent. Wells generally penetrate bedrock because sand or gravel deposits capable of supplying appreciable quantities of ground water are rare."

About 60 percent of the public water supply wells pump from sand and gravel aquifers and the remainder from rock aquifers, usually sandstone. Sixty to 400-foot deep bedrock wells have generally low yields but range from 10 to 60 gpm.

Sand and gravel wells are generally 25 to 100 feet deep with a wide range of yields from 20 to 500 gpm. The high yield wells are located generally in the northern extremity of the basin in the area of the Wisconsin glaciation and again in the southern extremity in the larger alluvial bed near the mouth of the Little Wabash River. Low to moderate yields exist generally between these regions, depending on the proximity of the wells to the preglacial riverbed or major tributaries to it.

The discharge at 90 percent flow duration at the gage near Clay City is about 7.9 cfs. This gives a dry weather yield of about 0.007 cfs per square mile, indicating that the ground water yield of the basin above this gaging station is moderate. The discharge at Carmi at 90 percent flow duration is about 34 cfs. This gives a dry weather yield

of about 0.011 cfs per square mile, indicating that ground water yield above this station is moderate and is somewhat better than that at the gage near Clay City. The only other gage in the basin for which there is a comparable record is on Skillet Fork at Wayne City. The discharge at 90 percent flow duration at this gage is about 1.0 cfs. This gives a dry weather yield of about 0.002 cfs per square mile, indicating the ground water yield above this station is low. Subsurface information, although sparse, indicates that high yielding wells are possible along the partially buried valley of the Little Wabash River.[9]

Quality of Water Available

Surface Water

Surface water quality in the main stem of the Little Wabash River and Skillet Fork, as shown in Tables V-2, V-3, and V-4, is generally fair. The range of chloride concentrations is from 385 to 4 mg/l, of sulfates is 307 to 5, and of total dissolved solids is 863 to 70. The maximum value quoted in each instance is higher than the maximum value to be tolerated in finished water according to the U. S. Public Health Service Drinking Water Standards as will be discussed later.[10] Average iron concentrations from two sampling stations are 3 mg/l and manganese concentrations for these same stations average 0.5 mg/l. These are both one order of magnitude higher than to be tolerated by these same U. S. Public Health Service Drinking Water Standards. The iron and manganese concentrations appear to be inherent water quality characteristics. The chlorides can be generally attributed to the oil field activity in the basin.

Throughout the entire basin the range in total hardness was from 391 to 38 mg/l.

The tributary streams showed higher ranges of concentrations than the main stem especially for constituents attributable to oil field activity. The total dissolved solids in these tributary streams ranged up to 2,080 mg/l. Surface water quality shows ranges of chlorides from one station on Muddy Creek in a heavily active oil field area due west of Olney of from ,100 to 13 mg/l with an average of seven samples between the years 1958 and 1963 of 208 mg/l. In a more recent survey in June of 1965, comparable average chloride concentrations were observed at two points in Skillet Fork near the confluence of the Little Wabash River. Chloride concentrations of this magnitude are due to brines from oil well drilling and occur in the highest concentrations in the small creeks. Another pronounced example of a chloride problem is that of the community of Olney which may have to abandon its Fox River water supply impoundment because of chloride concentrations as high as 800 mg/l entering from Coon and Richland Creeks.

Occasionally, in this same reservoir at Olney, the manganese concentration reaches 5 mg/l. At Wayne City and Clay City, the maximum manganese concentrations recorded were 1.4 and 1.2 mg/l respectively with average values of 0.6 and 0.4 mg/l.

The 1962 U. S. Public Health Service Drinking Water Standards publication indicates that the following concentrations should not be exceeded in finished drinking water if a more suitable supply is available: Chlorides, 250 mg/l; manganese, 0.05 mg/l; total dissolved solids, 500 mg/l; and iron, 0.3 mg/l. These values are exceeded in many parts of the basin which would indicate that treatment is necessary to remove these constituents for use on interstate carriers. (See Tables V-2, V-3, and V-4.)

The coliform count per 100 milliliters (ml) ranged from 104,000 to 10 of all samples analysed while the number of bacteria per milliliter for the same samples spaned the range of 320,000 to 4.

Ground Water

From data presented in Table V-5 from 12 wells in the basin, the range of total dissolved solids is from 1,330 mg/l to 294 mg/l. Iron concentrations vary from 3.8 to 0.0 mg/l. Manganese ranges from 0.3 to 0.0 mg/l. Values for sulfates range from a maximum of 273 to 1 mg/l and the concentrations for fluorides span the range 3.0 to 0.0 mg/l.

VI. THE ECONOMY

Introduction

An investigation of the population and economic characteristics and a projection of the probable growth of the area of concern of the reservoir projects provide a basis for determining the water requirements in terms of both quantity and quality for the area. The growth of an area depends not only on the characteristics of the area itself but, also, in varying degrees, on the type and extent of the growth of the Nation and the region of which it is a part. This discussion of the economy has been prepared within the general framework of the Projective Economic Study for the Ohio River Basin prepared by the A. D. Little Company, Inc.

To supplement that work, a special study has been conducted by the Louisville District of the U. S. Army Corps of Engineers utilizing historical employment data from the unemployment insurance program of the Bureau of Employment Security, U. S. Department of Labor. This study covered the Wabash and White River Basins as delineated in the Projective Economic Study of the Ohio River Basin.[11] The difference in total manufacturing employment between the two studies was only 4 percent or 1,000 employees in the year 2020. Thus there is no significant difference between the studies and no change was made in the index of output derived from the A. D. Little Company's study. The projections of productivity per employee made in the A. D. Little report are considered valid for use with the Louisville District employment projections.

Present

The area of economic influence includes the 11-county area of Clay, Cumberland, Edwards, Effingham, Hamilton, Jasper, Lawrence, Richland, Wabash, Wayne, and White in Illinois. The Mattoon area in Coles County is also included. There are two counties in the economic study area, Lawrence and Wabash, that are not considered in the Engineering Section of the report.

Agriculture, the largest single employment category in 1960, accounted for 30 percent of the total employment in 1950 and 20 percent in 1960 (see Table VI-1). Less than 5 percent of the State agriculture production is from the study area.[12] The amount of irrigation is insignificant. There is little softwood and even the hardwood forests are not of major consequence.

Extractive industries show a downward employment trend from 1950 to 1960. Output figures show a corresponding trend with little change in petroleum production and reserve. The only coal mined is in Wabash County which has one strip mine. No minerals were extracted in 1961 in Hamilton, Jasper, or Richland Counties. The value of all mineral industries was less than one million dollars for all eleven counties in 1961. The value of crude petroleum production in the eleven counties was approximately 110 million dollars, representing 48 percent of crude production in Illinois in 1961.[13]

Manufacturing employment accounted for less than 17 percent of total employment in 1960. In 1964, there were 10 manufacturing plants employing over 250 workers. Borg-Warner Corporation has a plant in Effingham

employing more than 1,000 persons which is the only really large plant in the study area. Its products fall into three classifications: Fabricated metals, non-electrical and electrical machinery. There are 21 plants in these 3 categories in the study area. Ten have over 100 employees. It seems logical that these will provide a nucleus for future expansion and a potential for attracting similar plants.[14]

In addition to fabricated metals and electrical and non-electrical machinery manufacturing, there is a nucleus for transportation and related equipment (bicycles, auto and bicycle tire and tube) manufacturing.

The study area has 4 plants with over 100 employees engaged in the manufacture of leather products. Shoes are the principal product with one plant producing leather gloves.

Table VI-2 shows the number and employment size of manufacturing plants in the study area.

Future

The past economy has been largely agricultural and has supported the rather large retail-wholesale trade category.[15] Projected prosperity of the area is based upon the nucleus of machinery, electrical machinery and related industries. Electrical machinery is the major growth category. Machinery is growing but at a much slower rate than electrical machinery. The index in Table VI-3 combines machinery and electrical machinery as was done in the A. D. Little study. It is this manufacturing complex

that will increase and upon which the projected employment and population will be supported. Urban area projections are based upon historical relationships between urban areas and the county in which the area is contained. (See Table VI-4.)

The population projection for Mattoon Township, adjacent to the study area, is 19,138 in 1960; 26,000 in 1980; and 60,000 in 2020.

Steam generation of power is projected by the Federal Power Commission to increase two and one-half times from 1960 to 1980.[16]

The projections in this section have been used for calculating future water supply and water quality needs in subsequent sections of this report.

VII. WATER REQUIREMENTS - MUNICIPAL AND INDUSTRIAL

Present Water Use

Water supply in the Little Wabash Basin is primarily for municipal and industrial use. The larger communities in the basin, the primary water users, are served by surface water supplies. Irrigation and stock watering use is negligible.

The range of average water use for communities having their own surface water supply is from 208 gallons per capita per day (gpcd) to 61 gpcd (see Table VII-1). The total average surface water use is 7.75 mgd, serving an approximate population of 70,000, about one-half the basin's total population.

Olney, the largest per capita water user, has an employment figure of 1,670 people from its eight major industries as of 1965.[17] This includes a meat processing plant employing 100 persons and using about 0.06 mgd, a milk processing plant employing 80 persons and using about 0.04 mgd, and a large metal fabrication plant employing 650 persons and using about 0.09 mgd. The water use figures for these three plants are 600, 500, and 140 gallons per employee per day respectively.

A large metal fabrication plant employing about 1,500 people uses about 0.20 mgd maximum from the municipal water system of Effingham. All industries in and near the community of Effingham use municipal water but none of the others are as large or use the amount of water as the above plant.

Mattoon, the largest water user in the basin as well as the largest community, has a broad economic base with no one industry dominating its economy, although it does have some industries employing in excess of 500 employees. All industries in and around Mattoon use municipal water supplies. Mattoon is far above the reservoir sites. Its wastes are discharged out of the basin. Therefore, its position is not influential to the report.

Flora supplies water to all industries in the community. The industries are engaged in finished goods production which involves assembly processes. Therefore, the industries require water primarily for sanitary purposes only. A shoe manufacturing plant employing about 450 people, two metal fabricating plants collectively employing 300 people, a millinery factory employing 140, and a new electronics firm employing 100 people all use municipal water. Water is also supplied to the community of Xenia.

Fairfield's largest water user is a light manufacturing company making die castings. It employs 900 people and uses 0.20 mgd.

The communities of Carmi and McLeansboro, in the extreme southern portion of the basin, are slowly breaking away from their heavy emphasis on mining but, as yet, have not attracted much industry into their areas.

There are three power generating plants presently in the basin, all in communities with surface water supplies[18] as listed below.

Community	Type Plant[a]	Capacity (megawatts)	Output (megawatts)	Average Water Use (gpd)
Altamont	I[b]	1.8	--	--
Carmi	I	7.4	3.65	2,000
Fairfield	S	12.5	5.0	30,000

a. I = internal combustion; S = steam generation.

b. Industrial plant.

The smaller communities are in general served by ground water supplies in the basin. The range of average water use values for these communities is from 101 gpcd to 19 gpcd (see Table VII-2). The total average municipal ground water use is 0.58 mgd, serving an approximate population of 9,200. The average ground water use figure per capita is 63 gpd. None of the communities supplied by ground water has any significant industrial development. The rest of the population in the basin is supplied by private wells.

Albion, with a 1960 population of 2,025, is the largest ground water user in the basin but it receives its water from outside the basin near Grayville along the Wabash River.

Existing Sources of Supply - Surface and Ground Water

Quantity - Surface Water

As seen in Table III-1, the one day once in thirty-year recurrence dependable low flow at Clay City is only 0.10 cfs or 0.065 mgd. At Carmi, with 93.7 percent of the total drainage area of the basin accounted

for, this same one day once in thirty-year recurrence dependable low flow is only 0.45 cfs or 0.29 mgd. These flows would not satisfy the present demands of the communities receiving water directly from the Little Wabash River (see Table VII-1), if they could not pump from impoundments on the stream or, in the case of the small community of Clay City, from a natural depression in the streambed.

On Skillet Fork, the only community receiving water from the stream is Wayne City. The one day once in thirty-year recurrence dependable low flow at this point is zero (see Table III-1).

The impoundments in the basin serve 12 of the 13 surface water using communities as tabulated below.

Community	Impoundment	Capacity (million gallons)	Firm Yield (mgd)
Mattoon & Neoga	Lake Mattoon Lake Paradise	5,500	12
Effingham	Lake Sara	4,500	7.2
Altamont	Altamont Reservoir	28	0.1
Louisville	Impoundment on Little Wabash River	10	0.7
Flora & Xenia	Impoundment on Little Wabash River	12	0.7
Olney[1]	Impoundment on Fox River Verner Lake New Olney Lake	--	5.3
Fairfield	Impoundment on Little Wabash River (side channel impoundment)[2]	350	4
Carmi	Impoundment on Little Wabash River	1,000	11

Community	Impoundment	Capacity (million gallons)	Firm Yield (mgd)
Wayne City	Impoundment on Skillet Fork	35	0.4
McLeansboro	Impoundment on Branch of Big Creek	--	0.4

1. Proposed impoundments will give total firm yield of 5.3 mgd (much of land purchased - construction to begin in summer of 1966). Present firm yield is 1.5 mgd.

2. Proposed impoundment (105 acres of land purchased - storage and firm yield calculated as though impoundment were existing).

Quantity - Ground Water

Existing ground water potential in the Little Wabash Basin is discussed extensively in Chapter V. It is generally concluded that high yield wells are possible in the extreme northern and southern parts of the basin along a preglacial riverbed and that moderate yield wells can be expected in the preglacial streambed with low yields in areas not in this streambed. The range of yields in the sand and gravel aquifer formed by this preglacial river is from 20 to 500 gallons per minute for wells 25 to 100 feet deep. This preglacial streambed is shown in Figure II as the area of excellent probability of sand and gravel aquifers.

Quality - Surface Water

The quality of surface water supplies in the basin is affected by algal growths and oil field pollution in some areas. The specific example of Olney, which may abandon its Fox River water supply impoundment because

of chloride concentrations as high as 800 mg/l entering it from Richland Creek in an oil field area, points out this problem most strikingly. Altamont and Louisville both have experienced taste and odor problems due to algal growths. This is one reason that Altamont is seeking a new water supply impoundment. Water samples at Clay City, Louisville, Wayne City, and Carmi near their water supply intakes do not indicate any striking problems. The average concentrations in mg/l of some constituents are shown below.

Community	Total Dissolved Solids	Cl	SO_4	Hardness	Fe	Mn
Louisville	201	17	27	137	--	--
Clay City	313	58	61	180	2.7	0.4
Wayne City	289	26	121	167	3.2	0.6
Carmi	292	71	38	155	--	--

A more complete tabulation of water quality data appears in Tables V-2, V-3, and V-4. Chloride concentrations in excess of 250 mg/l have been experienced at Clay City and Carmi.

Quality - Ground Water

The quality of ground water supplies in the basin summarized in Table V-5 indicates that in some instances total dissolved solids are above 500 mg/l, iron above 0.3 mg/l, and manganese above 0.05 mg/l. Sulfates are in excess of 250 mg/l at Dietrich. All values quoted are

maximum limits which should not be exceeded in finished water for use on interstate carriers according to the U. S. Public Health Service Drinking Water Standards, if more suitable supplies exist. The treated quality of these ground water supplies is satisfactory for use in these communities and should not now be a cause of their changing their source of supply.

Future Municipal and Industrial Water Requirements

At present the average per capita consumption in the Little Wabash Basin of surface water users is 111 gpcd and of municipally supplied ground water users is 63 gpcd. These figures account for only about 79,200 persons of a population of approximately 135,000. These remaining people use private wells for their water supply.

As a gross estimate of possible future per capita water use of the Nation and the State of Illinois, the following tabulation was abstracted from the Senate Select Committee Report on "Future Water Requirements for Municipal Use, Water Resources Activities in the United States," print No. 7.[19] This will put the per capita consumption figures (expressed in gallons per capita per day) derived for the Little Wabash River Basin in some perspective.

	1954	1980	2020
United States	147	148	152
Illinois	171	169	170

These figures were stated to have been developed on a conservative estimate of water use and that these municipal use figures in gallons per capita per day could conceivably increase to 185 by the year 1980 and to

225 by the year 2000 and then generally level off from that point in time. This increase is based on a shift from rural to urban living with an associated higher industrial base and increased water use for cleaning, air conditioning, and lawn watering to name just a few uses.

At the present time Olney, supplying water for domestic and all major industrial use, has an average water use figure of 208 gpcd far above any other community in the basin. Industry in Olney employs many more people than the population would suggest, indicating that people are commuting to work from areas not supplied by water from Olney's municipal facilities. In the future, Olney should still maintain a high level of industrial development and continue to be an employment center for the area, but diversity of industry and the expansion of municipal water facilities to encompass a larger percentage of the working force's families should temper Olney's per capita water use figure.

The water use figures for the other communities in the basin are more in line with those expected in an agriculturally oriented area intermixed with spotty industrial development. Tables VII-3 and VII-4 show projected water use patterns for the major communities in the basin.

The following tabulation lists the surface water supplied communities and the firm yields from their present sources of supply.

Community	Present Use 1965 (mgd)	Projected Use 1980 (mgd)	2020 (mgd)	Firm Yield (mgd)
Mattoon & Neoga*	2.4	4.5	13.2	12
Effingham	1.0	2.0	4.1	7.2
Altamont*	0.14	0.2	0.7	0.1
Louisville	0.1	0.2	0.6	0.7**
Flora, Xenia, & Clay City*	0.63	1.1	3.3	0.7**
Olney	1.5	2.1	3.4	5.3
Fairfield	1.0	1.5	3.2	4
Carmi	0.75	1.3	3.8	11
Wayne City	0.07	0.1	0.4	0.4
McLeansboro*	0.23	0.4	0.9	0.4
Total	7.8	13.4	33.6	

*Points of potential water supply deficiencies.
**Effluent flows from Altamont and Effingham should increase the flow at Louisville and Flora by 0.1 mgd by 1980 and 2.5 mgd by the year 2020.

These projections are based on the assumption that industrial and population expansion will occur in areas already possessing municipal facilities for water supply and waste water disposal. The water use figures derived are based on projected population, per capita consumption to include industrial growth in the community, and percent of the population

using public water supplies. Total municipal and industrial surface water use should increase to 13.4 mgd by the year 1980 and to 33.6 mgd by the year 2020. Future total municipal ground water use should reach 1.14 mgd by the year 1980 and increase to 2.52 mgd by the year 2020.

Water supply deficiencies are noted as follows.

Community	Year of First Need	2020 Deficiency (mgd)
Mattoon and Neoga	2010	1.2
Altamont	1970	0.6
Flora, Xenia, and Clay City	1970	2.6
McLeansboro	1980	0.5

As indicated in the tabulation on page VII-9, the flow need in the year 1980 at Flora is 1.1 mgd and by the year 2020 the flow need is 3.3 mgd. In the year 1980, all except 0.3 mgd of the 1.1 mgd can be furnished by the natural flow in the stream. By the year 2020, all except 0.1 mgd of the total 3.3 mgd need at Flora can be furnished by natural flow in the stream supplemented by upstream water use by the communities of Altamont and Effingham. The organic quality of the water used by these upstream communities would be recovered after traveling over 30 miles downstream in the Little Wabash River so would be suitable for a water supply source after treatment. With the proposed reservoir intervening, these flows would be mixed with reservoir water which would be of much better quality.

Supplemental flows of 0.3 mgd in the year 1980 and 0.1 mgd in the year 2020 could be supplied from storage in the Louisville Reservoir. These flows in addition to the unregulated streamflow in this stream reach will be sufficient to satisfy the water supply needs. Flora has expressed a willingness to purchase storage in the Louisville Reservoir for water supply.

The communities served by ground water supplies will generally use less than 0.2 mgd except for three communities (see Table VII-4). These three communities are Albion, receiving water from a well field near Grayville on the Wabash River, Crossville and Teutopolis both in areas of, or near areas of, excellent probability of ground water shown in Figure II. All of these communities should be able to obtain average yields of 350 gpm per well of a well field with proper development. This will be sufficient to meet their needs through the year 2020.

VIII. WATER QUALITY CONTROL

Pertinent Physical Characteristics Affecting Water Quality

Both the Little Wabash River and Skillet Fork are low-gradient streams, especially in the middle and lower portions of the basin where most of the pollutional loadings occur.

The community of Carmi maintains a water supply dam which, while only 5 feet high, is on a riffle in the Little Wabash River. Water behind this dam is at points at least 20 feet deep and 140 feet wide. Even 7.7 miles upstream from the dam the depth is at least 11 feet and the width 120 feet. Three and two tenths miles up the Skillet Fork above the confluence of Skillet Fork and the Little Wabash River in this same Carmi water supply impoundment, the water is 8 feet deep and the width 65 feet. These depths were taken when the flow at the U. S. Geological Survey gaging station at Carmi was 135 cfs. The average stream gradient in this river reach in both the Little Wabash River and Skillet Fork is 0.25 feet per mile.

According to a paper by C. J. Velz on the "Significance of Organic Sludge Deposits,"[20] the stream velocity below which organics will settle is on the order of 0.6 fps. Once organic particles settle out, a velocity in the range of 1.0 fps is necessary to put these particles in suspension again. These quoted values are given as gross figures realizing that settling velocities vary with particle size.

Based on the velocities quoted and cross sections of the Carmi impoundment, flows of 1,200 cfs would be required year-round to maintain non-settling velocities in this impounded reach. If the impoundment were removed, there would still be pools, some of which would be 3 miles long and 15 feet deep. Flows of 800 cfs year-round would be needed to maintain non-settling velocities assuming no dam were at Carmi. However, a lower flow level than the 800 cfs without the dam at Carmi will be sufficient to meet the water quality criterion to be discussed later in this chapter.

To maintain 800 cfs at Carmi with the Carmi dam removed would require 30 percent regulation of the drainage area. With the dam in place, the flow of 1,200 cfs needed represents 50 percent of the mean annual flow at Carmi. Only 28 percent of the drainage area above Carmi will be partially regulated by these two proposed reservoirs. Therefore, even with complete regulation of the streamflow above these two reservoirs, settling would still occur in this impoundment at Carmi.

A study of the dissolved oxygen analyses at the water supply intake at Carmi vs. flow for 94 samples shows the following:

Flow Values in cfs Based on Yearly Sampling from 1959 to 1964 for Following Ranges of D.O.'s in mg/l

	1<DO<2	2≤DO<3	3≤DO<4	4≤DO<5	5≤DO<6	6≤DO<7	DO≥7
Max	4,650	5,350	4,780	6,100	1,390	4,830	12,500
Min	50	8	8	10	13	16	16
Med	177	407	125	80	74	110	88
Mean	1,010	958	621	676	220	819	2,830

Flow Values in cfs Based on June through September Samples from 1959 to 1964 for Following Ranges of D.O.'s in mg/l

	1<DO<2	2≤DO<3	3≤DO<4	4≤DO<5	5≤DO<6	6≤DO<7	DO>7
Max	177	5,350	4,780	6,100	1,390	4,830	No
Min	74	46	11	11	67	27	Samples
Med	125	453	195	145	82	110	
Mean	125	108	797	1,093	351	934	

We are not able to assume from this that any definitive statements can be made about what flow level would be needed to maintain any given D.O. value in the Carmi water supply impoundment.

Recalling that 50 percent regulation of the drainage area would be needed to maintain sufficient velocity in the Carmi pool and that only, at most, 28 percent of the basin will be regulated and that only partially, it can be concluded that it is not possible without transbasin diversion to provide sufficient streamflow to ensure non-settling velocities in the Carmi impoundment. Some additional water could be improved in quality for about 6 to 8 miles of the head ends of the pool in both Skillet Fork and the Little Wabash River if the flow were completely regulated at the damsites but a 5 mg/l dissolved oxygen concentration could not be maintained throughout the stream reach, unless mechanical reaeration techniques were employed.

If the Carmi dam were removed, a low head pumping pool were maintained, and a firm flow of 11 mgd were provided from the upstream

reservoirs of Louisville and Helm, the stream would have water of higher dissolved oxygen quality. This will be further elaborated on in the Flow Regulations Section at the end of this chapter.

Municipal, Industrial, and Agricultural Pollution and Natural Organic Degradation

Above the Helm Reservoir, virtually no population centers exist. Below the reservoir site the only significant community is Wayne City with a projected population of 4,500 in the year 2020. The major causes of stream degradation in Skillet Fork below the reservoir will be from agricultural runoff, oil field wastes, and natural organic degradation caused by decaying vegetable matter, primarily leaves and logs, which fall into or are washed into the stream.

Above the Louisville Reservoir, the communities of Effingham and Altamont discharge their wastes after secondary treatment into the Little Wabash River via tributary streams. When the reservoir, as presently proposed, is built, these tributaries will form two of the fingers of the reservoir. Increased algal concentrations will result from waste discharges in these shallow fingers even with secondary treatment. If present oil field management is maintained, average and average maximum chloride concentrations of 40 and 100 mg/l can be expected as discussed in Chapter III. With stricter enforcement of existing State legislation dealing with oil field activities expected, these chloride concentrations should be reduced.

The following tabulation lists the waste discharging communities in order of the introduction of their wastes to the Little Wabash River, below the Louisville Reservoir site, the type of treatment, and the receiving stream.

Community	Treatment	Receiving Stream
Louisville	Oxidation pond	Little Wabash River
Clay City	Secondary	Little Wabash River
Noble	Oxidation pond	Hog Run Creek
Olney	Secondary	Fox River
Flora	Secondary	Seminary Creek to Elm River
Cisne	Secondary	Deer Creek to Elm Rv.
Fairfield	Secondary	Pond Creek
Albion	Secondary	Butter Creek
Crossville	Secondary	Little Wabash River
Carmi	Secondary	Little Wabash River

For further details see Table VIII-1 and Figures II and IV.

The communities of Mattoon and McLeansboro both receive their water supply from the Little Wabash Basin and discharge their wastes outside the basin; Mattoon to the Embarrass River via Kickapoo Creek, and McLeansboro to the Saline River via Ten Mile Creek.

Flora, Olney, Fairfield, and Albion are the major communities below the Louisville Reservoir which discharge wastes that eventually reach the Little Wabash River above the confluence of Skillet Fork. The approximate

stream miles from the points of discharge to the Little Wabash River are respectively 33, 18, 10, and 9 miles. Because of the assimilative capacities of these tributary streams and the projected size of these communities, Fairfield is found to be the major point of need on the mainstem of the Little Wabash River above Skillet Fork. The projected effluent loadings shown in Table VIII-2 are at the point of discharge, not their entrance to the Little Wabash River.

At present, the only significant community discharging wastes directly into the Little Wabash River is Carmi, after treatment to remove 85 percent of the first stage B.O.D.

The rural farm area of the Little Wabash River is similar to that of Skillet Fork. Cattle and hog production and the raising of corn, soybeans, and wheat are the major agricultural activities in the basin. The State of Illinois ranks first in the use of anhydrous ammonia, a high nitrate content fertilizer, and first in combined commercial fertilizer use.[21] The same general agricultural runoff can be anticipated from both Skillet Fork and the Little Wabash River Basins. Agricultural loadings may contain high nitrate, phosphate, and B.O.D. concentrations which increase the stream biomass.

Extensive tree-lined banks are the cause of another form of stream loading. This is the natural organic degradation of the stream due to the B.O.D. exertion of leaves, logs, and twigs which fall or are washed into the streams. These loadings are especially significant in a low-gradient, slow moving stream with deep pools or impounded areas all of which characterize the Little Wabash River and Skillet Fork in their

lower reaches near and in the Carmi water supply impoundment. Both the agricultural runoff and the natural organic degradation will increase the B.O.D. loadings, lower the D.O. and increase the biomass of the streams.

Non-biodegradable constituents in the stream will come from two primary sources, the oil industry and agriculture. Oil scum and brine wastes are occasional problems from overspilling from evaporation ponds, primarily during higher flow conditions when rainfall will cause these ponds to fill. Reinjection of these chlorides or other adequate control of these wastes at the source should be encouraged.

The second form of non-biodegradable pollutant is pesticides. These can enter the stream from agricultural use in two primary ways. First, soon after application to the crops they can be washed off by heavy rains. This is unavoidable and generally of not as much concern if proper application techniques and doses are followed. The second, and often disastrous entrance of pesticides, is through dumping excess quantities of material and/or washing equipment in the streams. This is almost certain to produce lethal highly concentrated non-dispersed loadings of materials.

High iron and manganese concentrations are inherent characteristics of the stream and cannot be significantly altered by flow regulation.

The biological quality at the raw water intakes of Carmi and Louisville appear acceptable. At Carmi, the maximum coliform concentrations per 100 ml were 22,000 and the geometric average 195. At Louisville, the maximum coliform concentration per 100 ml was 26,000

and the geometric average 486. Higher average coliform concentrations were found above Effingham in the Little Wabash River and in Muddy Creek. See Table V-2 for further details and Figure III for the sampling locations.

Water Quality Criteria

It is anticipated that the Little Wabash River and Skillet Fork will continue to be used primarily as municipal and industrial water supply sources and waste water carriers. Another important use of the streams is recreational fishing. Commercial fishing is practiced in the Little Wabash Basin by a few people. Only a limited irrigation use is anticipated.

The biological quality of the water was considered in relation to the following criteria. The Manual of Recommended Water Sanitation Practice of the U. S. Public Health Service has been used as a guide to acceptable raw water quality and is used here to select objectives for the maximum coliform concentration in the raw water at water treatment plant intakes. Coliform densities in excess of 5,000 per 100 ml in 20 percent of the samples in any month or 20,000 per 100 ml in more than 5 percent in any month should be avoided, even with coagulation, filtration, and post chlorination.[10] If greater coliform reduction is needed to assure good quality water from a bacterial standpoint, either in the stream or at downstream water intakes, this should be effected by chlorination of sewage treatment plant effluents.

Maintenance of aesthetically pleasing conditions, including a balanced aquatic environment even below municipal and industrial waste treatment plants, is the goal upon which the following criteria are based. The U. S. Public Health Service conducted studies on aquatic life in the Cincinnati, Ohio, area and found that for a well-rounded, warm-water fish population the dissolved oxygen concentration in a stream should not be below 5 mg/l for more than 8 hours of any 24-hour period and at no time should it dip below 3 mg/l. If this goal of 5 mg/l of dissolved oxygen is met, the stream will also be acceptable as a raw water supply for industries and municipalities and for aesthetic and recreational enjoyment.

As previously discussed in this chapter, the Carmi water supply impoundment under present conditions will not always meet this criterion of 5 mg/l of D.O. nor even the 3 mg/l minimum criterion. This occasionally lower D.O. will not affect the water as a source of water supply for Carmi.

Flow Regulation

The draft-on-storage required in the basin for water quality control varies considerably, depending on the extent and level of protection sought in meeting the water quality criterion chosen. The maximum planned allowable conservation storage of the two reservoirs is 93,000 acre-feet.

The following paragraphs indicate a wide range of drafts-on-storage to satisfy various extents of water quality protection in the basin without regard to the reasonableness or wisdom of providing some of these drafts-on-storage.

There are basically four alternative methods of solving the two problems in the basin. The two problems are the future urban growth of the area producing increased waste loadings to the stream which will require flow regulation to assimilate the treated wastes from these communities, and the previously discussed problem of the stream reach immediately above the community of Carmi in the present Carmi water supply impoundment. The four approaches to these two problems follow:

1. Provide sufficient streamflow in the basin to assimilate the treated wastes of the communities as projected for the year 2020 by meeting the criterion chosen in all stream reaches except the Carmi impoundment.

2. Provide sufficient streamflow in the basin to meet the water quality criterion chosen throughout the basin including the Carmi impoundment with the dam remaining at Carmi.

3. Removing the Carmi dam and providing sufficient streamflow to satisfy the water supply needs of Carmi, and the water quality criterion in all reaches of the stream except for some deep pools above the present Carmi dam which will still exist as natural pools in the stream.

4. Removing the Carmi dam and providing sufficient streamflow to satisfy the water quality criterion in the natural pools above Carmi as well as throughout the remainder of the stream reaches. This last alternative will provide enough streamflow to satisfy both the water supply and water quality control needs at Carmi.

The draft-on-storage required at the point of need for each of these alternatives listed by number follows:

1. 12,200 acre-feet

2. 630,000 acre-feet*

3. 16,400 acre-feet

4. 63,000 acre-feet*

*The values with asterisks (*) are present and year 2020 draft-on-storage needs; those without, year 2020 needs only.

The release schedule for alternative (2) is for a constant release of 1,200 cfs. This has been previously shown to be greater than the proposed combined conservation storage in the two reservoirs.

The release schedule for alternative (4) would be for 300 cfs in summer (June, July, August, and September); 150 cfs in the spring and fall months (March, April, May and October and November); and 110 cfs in the winter months (December, January, and February).

The release schedule for alternatives (1) and (3) are basically the same except that 11 mgd of water for water supply at Carmi should be provided in addition to the water quality water released and needed at Carmi in the year 2020. The additional water supply water for Carmi of alternative (3) can come from either the Louisville or Helm Reservoir. The basic releases to satisfy the water quality criterion, however, require releases from each reservoir. Alternative (1) therefore will be discussed.

In the year 2020 there will be a total water quality draft-on-storage need of 12,200 acre-feet to meet water quality objectives. At the primary point of need, downstream of Carmi, the water quality draft-on-storage required is 11,000 acre-feet. Of the total 12,200 acre-feet required under alternative (1), 9,000 acre-feet are required at Pond Creek on the Little Wabash River from Louisville Reservoir to satisfy the waste demand from Fairfield. The need to satisfy the waste demand at Wayne City on the Skillet Fork is 3,200 acre-feet to be supplied from the Helm Reservoir. These combined drafts-on-storage to satisfy the requirements at Wayne City and Fairfield will be sufficient to meet the water

quality needs below Carmi. These drafts-on-storage are based on expected one in 10-year recurrence interval droughts. Draft-on-storage needs to meet other levels of drought protection are shown for the years 1980 and 2020 in Table VIII-3.

These draft-on-storage values are for the critical points mentioned; Fairfield, Wayne City, and Carmi, and do not include transportation and evaporation losses. Flow regulation made possible by this storage is not provided as a substitute for adequate treatment or control at the source.

The 1980 and 2020 release schedule for flow at the critical points from both Louisville and Helm are shown for alternative (1) below. Recall that the total flows at Carmi under assumption (3) would be increased by 11 mgd and could be supplied from either Louisville or Helm, or both.

	1980		2020	
	Louisville (mgd)	Helm (mgd)	Louisville (mgd)	Helm (mgd)
Summer June, July, August, September				
Wayne City	----	5.2	----	12.9
Fairfield	19.2	---	38.8	----
Carmi*	16.2	4.5	47.6	16.9
Spring - Fall March, April, May, October, November				
Wayne City	----	1.3	----	4.5
Fairfield	4.5	---	10.3	---
Carmi	4.5	1.3	9.5	3.4

	1980		2020	
	Louisville (mgd)	Helm (mgd)	Louisville (mgd)	Helm (mgd)
Winter December, January, February				
Wayne City	----	0.6	----	3.2
Fairfield	3.9	---	6.2	---
Carmi	3.9	0.6	4.8	1.7

*In 1980, upstream needs are controlling during summer flows. In 2020, upstream needs are controlling during all but summer flows.

The release schedules shown should not be regarded as an operating policy for the water quality releases from the reservoirs. These releases are average flows. Flows will need to be increased when the mean temperature is above the long-term mean temperature for the corresponding period. These streamflows are considered reasonable for reservoir design but actual regulation should be adjusted based on actual waste loadings experienced in the future.

To ensure that water of acceptable quality is released from these reservoirs, a multiple-level outlet structure, with at least three openings is recommended for each. The openings should be located at the bottom of the seasonal pool, the middle of the conservation pool, and below the conservation pool. Monitoring of the water quality at each of these levels would facilitate the selection of the opening or combination of openings used to make best use of the water available.

Observation of water quality by a monitoring network at downstream points and use of the U. S. Weather Bureau stream forecasting service would further aid in deciding how best to manage the water available for release.

IX. BENEFITS

Water Supply Benefits

Water supply needs exist or will exist by 2020 in the Little Wabash Basin. The costs of supplying these needs from alternative sources and from storage in the Louisville and Helm Reservoirs, including pumping and transportation costs, are listed below.

Community	Greatest Need to Year 2020 (mgd)	Annual Alternative Cost of Supplying Need (dollars)	Annual Cost from Proposed Reservoir Storage* (dollars)
Mattoon and Neoga	1.2	10,100	24,500
Altamont	0.6	23,900	33,000
Flora, Xenia, and Clay City**	2.6	2,100	0
McLeansboro	0.5	27,600	39,600

*Annual cost includes only pumping and transportation costs from proposed reservoirs or from downstream points and not cost of storage in the proposed reservoirs.

**As discussed in Chapter VII, need for 1.1 mgd exists in 1980 and can be satisfied by additional 0.3 mgd from storage.

The only community which could benefit from water supply storage through the year 2020 in either the louisville or Helm Reservoirs would be Flora, which has already expressed a willingness to purchase

storage in the Louisville Reservoir. The storage needed at Flora, as noted in Chapter VII, must be sufficient to maintain a flow of 1.1 mgd at the point of need in the year 1980 and 3.3 mgd in the year 2020. The latter flow should be supplemented by 2.5 mgd from upstream water use from the communities of Effingham and Altamont.

Alternative ways of providing the needed water would be an upstream impoundment on a tributary to the Little Wabash River above the water supply intake of Flora, from which storage would be released to the low head impoundment at Flora as needed, or a well field to provide the required water. The former alternative is considered to be the least costly way of providing water to Flora.

In order to provide a minimum flow of 1.1 mgd in the year 1980, a small amount of storage in addition to present storage at Flora would be needed. The estimated first cost of a structure to provide needed storage is $49,000. The annual cost based on a 100-year amortization period at an interest rate of 3 1/8 percent is $2,100 including operation and maintenance costs of $500. Year 2020 flow levels of 3.3 mgd would be met by the then existing storage plus estimated upstream effluents available in 2020, and no additional storage would be needed. All values in this report are based on construction costs in the year 1965.

Water Quality Control Benefits

The benefits derived from maintaining water quality in a basin are many and varied. Most of these cannot readily be assigned a dollar value because of their indirect influence on the public welfare. They range from preventing nuisance conditions downstream

of industrial or municipal waste discharges to the maintenance of more pleasant aesthetic conditions, leading to increased use of the river and its banks for recreation, such as fishing, hiking and picnicking, and for building homes with a resultant increase in land values in the vicinity of the river. Improved quality of water for water supplies and maintenance of public health are also desirable benefits.

Maintaining an environment in the rivers for a balanced warm-water fish population will permit recreational use of the stream by fishermen. The U. S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, has estimated the recreational use of the Little Wabash Basin streams and lakes in fisherman days per year.[22] In 1960, the Little Wabash Basin provided approximately 223,600 fisherman days of recreation. Of this amount, nearly 30 percent occurred in the Little Wabash River and tributaries, including Skillet Fork. The other 70 percent of the fishing was done in the ponds and lakes of the basin.

The Bureau of Sport Fisheries and Wildlife[22] has estimated that recreational use will increase, raising the total fisherman days per year to 319,000 in the year 1980 and to 410,500 in the year 2010 for the entire basin, including ponds, lakes, and streams.

Assuming the Louisville and Helm Reservoirs are built as planned, the 1980 recreational need can be satisfied but, by the year 2010 without additional recreational outlets in the basin,

there will be a need for additional sources of fishing sites to accommodate 50,600 fisherman days per year. These additional 50,600 fisherman days per year by the year 2010 represent 75 percent of the present yearly stream fishing pressure in the basin. This recreational need could be satisfied by the regulated stream reaches below the proposed reservoirs.

These recreational benefits will develop gradually due to the greater proportion of fishermen who fish in ponds and lakes from boats and shoreline rather than wade or fish from the banks of the rivers. Limited public access to the streams at present is a strong deterrent to increased fisherman use.

There were four alternative methods of satisfying the water quality needs downstream of the Louisville and Helm Reservoirs discussed in Chapter VIII. For convenience these alternatives will again be listed.

1. Provide sufficient streamflow in the basin to assimilate the treated wastes of the communities as projected for the year 2020 by meeting the criterion chosen of 5 mg/l D.O. in all stream reaches except the Carmi impoundment.

2. Provide sufficient streamflow in the basin to meet the water quality criterion chosen throughout the basin, including the Carmi impoundment, with the dam remaining at Carmi.

3. Remove the Carmi dam and provide sufficient streamflow to satisfy the water supply needs of Carmi and the water quality criterion in all reaches of the stream except for some deep pools above the present Carmi dam which will still exist as natural pools in the stream.

4. Remove the Carmi dam and provide sufficient streamflow to satisfy the water quality criterion in the natural pools above Carmi as well as throughout the remainder of the stream reaches. This last alternative will provide enough streamflow to satisfy both water supply and water quality control needs at Carmi.

The benefits of alternative 1 are calculated on the basis of the least costly method of providing streamflow in the basin of comparable quality to that which would result from regulated releases from Louisville and Helm. The first method of providing this quality considered was by transbasin diversion of 12,200 acre-feet of water for the points of need. This was not found to be the least costly method of maintaining water quality. The second method considered was to build two single-purpose reservoirs, one with a storage at the point of need of 3,200 acre-feet on Brush Creek, a tributary to Skillet Fork, and the other with 9,000 acre-feet of storage at the point of need near Effingham on a tributary to the Little Wabash River. The storage of 9,000 acre-feet was found to be the least costly water quality alternative to the Louisville Reservoir. The third method considered was to

provide holding ponds after secondary treatment for the wastes of the most significant communities in the basin. This was found to be the most economical method of maintaining water quality in Skillet Fork.

The needs in the basin are for 9,000 acre-feet of storage at the mouth of Pond Creek due to waste loadings from Fairfield, for 3,200 acre-feet of storage at Wayne City, and for 11,000 acre-feet of storage at Carmi which need can be satisfied if upstream needs are satisfied.

The least costly set of alternatives to effect the same water quality in the basin would be to provide holding ponds at Wayne City and eliminate the alternative reservoir on Brush Creek with storage of 3,200 acre-feet. This would then require that the least costly alternative to the Louisville Reservoir, the 9,000 acre-feet storage for Fairfield, would have to be an enlarged reservoir to provide 11,000 acre-feet for quality control water at Carmi.

The total cost of providing 11,000 acre-feet of storage in the single purpose Effingham reservoir would be $3,560,000. The operation and maintenance cost and the annual amortization of this total cost over a 100-year period at an interest rate of 3 1/8 percent would bring the total annual cost of this structure to $139,000, of which $22,000 are operation and maintenance costs.

The total cost of constructing holding ponds at Wayne City would be $59,000. The ponds would be rebuilt at the end of a 50-year life, and the estimated first cost for doing this is $36,000. With an amortization period of 100 years at an interest rate of 3 1/8 percent, the annual cost of these lagoons would be $7,100. Of this $7,100 annual cost, $4,900 would be operation and maintenance costs.

The minimum annual benefit attached to storage of 9,000 acre-feet of quality control water in the Louisville Reservoir is $114,000. The storage of 3,200 acre-feet of quality control water would have a minimum annual benefit of $32,000.

The benefits for the remaining alternatives (2, 3, and 4) will be based on the benefit of alternative 1 as follows.

Benefit of alternative 2 = (benefit of alternative 1) + (increased fishing benefit of 35 miles of stream).

Benefit of alternative 3 = (benefit of alternative 1) + (increased fishing benefit of 30 miles of stream) - (cost of providing a water supply for Carmi of 4,200 acre-feet storage at Carmi).

Benefit of alternative 4 = (benefit of alternative 1) + (increased fishing benefit of 35 miles of stream).

For all alternatives, the minimum storage of water in the Louisville and Helm Reservoirs for quality control must be as in alternative 1 with the remaining quality control water to be stored in the reservoir with the least costly storage.

The total benefits of each alternative are listed below along with the total storage values at the point of need.

Alternative	Total Storage in Acre-Feet at Points of Need	Total Minimum Annual Benefit (dollars)
1	12,200	146,000
2	630,000	160,000
3	16,400	132,000
4	63,000	160,000

Alternatives 1 and 2 would also have an inappreciable boating benefit of generally local nature due to the lack of general public access to the streams. Alternative 2 cannot be satisfied hydrologically from storage in the Louisville and Helm Reservoirs as discussed in Chapter VIII. Alternative 3 has a higher storage and a lower benefit than alternative 1 so should be rejected as economically inefficient. Alternative 4 would preempt most of the total planned conservation storage of the two reservoirs (93,000 acre-feet). This alternative should be provided only if storage of (63,000 - 12,200) acre-feet has a cost equal to or less than (160,000 - 146,000) $14,000.

For these reasons, alternative 1, while not meeting the 5 mg/l dissolved oxygen criterion in the impounded reach above Carmi, appears to provide the highest level of benefit protection for the least cost of all the alternatives considered.

To summarize both water supply and quality control benefits in the basin, the following should be provided.

1. For water supply a minimum flow of 1.1 mgd in 1980 and 3.3 mgd in 2020 at Flora at a minimum annual value of the benefit of $2,100.

2. For quality control a minimum storage for Wayne City of 3,200 acre-feet from Helm Reservoir with a minimum annual value of the benefit of $32,000 and a minimum storage for Fairfield of 9,000 acre-feet from Louisville Reservoir with a minimum annual value of the benefit of $114,000. The flows from these combined storages will be sufficient to satisfy the needs for water quality control below Carmi as discussed extensively in alternative 1 and will provide widespread benefits throughout the basin.

X. BIBLIOGRAPHY

1. U. S. Department of the Interior, Geological Survey prepared in cooperation with the State of Illinois and with other agencies, "Surface Water Records of Illinois, 1963."

2. U. S. Army Engineer District, Louisville Corps of Engineers, "Pertinent Data and Plan Considered, Louisville Reservoir, Little Wabash River, Illinois, for Public Hearing at Louisville, Illinois, November 10, 1965."

3. U. S. Army Engineer District, Louisville Corps of Engineers, "Pertinent Data and Plan Considered, Helm Reservoir, Skillet Fork, Illinois, for Public Hearing at Fairfield, Illinois, November 9, 1965."

4. Illinois State Water Survey, "Quality of Surface Waters in Illinois," by T. E. Larson and B. O. Larson, Bulletin 45, Urbana, Illinois, 1957.

5. Illinois Department of Mines and Minerals, Division of Oil and Gas, "An Act in Relation to Oil, Gas, Coal and Other Surface and Underground Resources and Rules and Regulations." Revised edition 1961 and amendments effective April 1, 1964.

6. Illinois Department of Conservation, Division of Fisheries, "Inventory of the Fishes of the Wabash River Basin, 1962." Page 28.

7. U. S. Department of Commerce, Weather Bureau, "Climatological Data-Illinois Annual Summary, 1964." Vol. 69, No. 13.

8. Division of the Illinois State Geological Survey, Circular 212, "Groundwater Geology in Southern Illinois-A Preliminary Geologic Report." Urbana, Illinois, 1956. Circular 225 "Groundwater Geology in South-Central Illinois-A Preliminary Geologic Report." Urbana, Illinois, 1957. Circular 248 "Groundwater Geology in East-Central Illinois-A Preliminary Geologic Report." Urbana, Illinois, 1958.

9. Letter Report by U. S. Department of the Interior, Geological Survey, "Preliminary Examination of the Ground-Water Conditions in the Little Wabash Basin in Illinois." August 11, 1964.

10. U. S. Department of Health, Education, and Welfare, Public Health Service, "Public Health Service Drinking Water Standards, 1962." PHS Publication No. 956.

11. Arthur D. Little Company, Inc., "Projective Economic Study of the Ohio River Basin, Appendix B, Ohio River Basin Comprehensive Study." August 1964. Vol. III.

12. U. S. Department of Commerce, Bureau of the Census, "Census of Agriculture, 1959."

13. U. S. Department of the Interior, Bureau of Mines, "Minerals Yearbook, 1960-1961." Vol. III, "Area Reports."

14. U. S. Department of Commerce, Bureau of the Census, "Location of Manufacturing Plants by County, Industry, and Employment Size." Census of Manufactures, 1958.

15. Boyce, Ronald R., ed., "Regional Development and the Wabash Basin." University of Illinois Press. Urbana, Illinois, 1964.

16. Letter dated May 17, 1965, to the U. S. Public Health Service Project Director, Ohio River Basin Project, Cincinnati, Ohio, from the Federal Power Commission Regional Engineer, Chicago, Illinois.

17. "Olney, Fastest Growing City." Evansville Courier and Press, August 15, 1965. Section I, page 2. Evansville, Indiana.

18. Federal Power Commission, "Principal Electric Power Facilities in the Wabash River Basin-Plant List-Illinois," as of 1963. Presented at Conference on Coal Production and Power Generation and on Economic Projections, Wabash River Basin, Corps of Engineers, Louisville, Kentucky, August 9, 1965.

19. U. S. Congress, Senate, Select Committee on National Water Resources, "Water Resources Activities in the United States-Future Water Requirements for Municipal Use," 86th Cong., 2d sess., Committee Print No. 7, January 1960. Washington, Government Printing Office.

20. U. S. Department of Health, Education, and Welfare, Public Health Service, "Oxygen Relationships in Streams." Technical Report W58-2, 1958. Pages 47-61.

21. Illinois Department of Agriculture, publication No. (11365-6-65).

22. U. S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, preliminary tabular material on the "Fish and Wildlife Resources of the Ohio River Basin."

23. U. S. Department of Health, Education, and Welfare, Public Health Service. A cooperative State-Federal report, "1963 Inventory of Municipal Water Facilities," and supplemental information from letters and trips in the study area. PHS Publication No. 775 (revised), Vol. V.

Table III-1

Proposed Physical Data[1]
Louisville and Helm Reservoirs
Little Wabash River Basin

	Louisville[a]	Helm
Drainage Area (Sq. Mi.)	661	210
Storage (Acre-Feet)		
Minimum	38,000	12,000
Conservation	46,000[b]	47,000[c]
Seasonal	35,000	15,300
Flood Control	146,000	114,500
Total	230,000	173,500
Pool Elevations (Ft. m.s.l.)		
Minimum	469	453
Conservation	469-476	453-466
Seasonal	476-480	466-468.5
Flood Control	476-490	466-481
Pool Areas (Acres)		
Minimum	5,000	2,040
Conservation	7,750	5,300
Seasonal	9,400	6,000
Flood Control	13,500	10,000

1. U. S. Army Corps of Engineer District, Louisville, Kentucky, from November 1965 Public Hearings Pamphlets of Pertinent Data and Plans Considered for the Louisville Reservoir and the Helm Reservoir.

a. Louisville Dismal Site does not impound Crooked Creek.

b. Tentative allocation of 9,000 acre-feet for water quality control and 37,000 acre-feet purchased by the State of Illinois for water supply.

c. Tentative allocation of 3,200 acre-feet for water quality control and 43,800 acre-feet purchased by the State of Illinois for water supply.

Table V-1

Streamflow Data
Little Wabash River Basin

U.S.G.S. Stream Gaging Station	Period of Record	Drainage Area (Square Miles)	Flows During Period of Record* Max.	Min.	Avg.	Dependable Low Flow A.	B.
			CFS	CFS	CFS	CFS	CFS
Little Wabash River at Carmi, Illinois	1939-1963	3,111	46,900	0.6	2,557	0.45	4.0
Little Wabash River below Clay City, Ill.	1914-1963	1,134	47,000	0	894	0.10	0.60
Skillet Fork at Wayne City, Illinois	1908-1912 1914-1921 1928-1963	464	51,000	0	396	0	0.03

* U. S. Department of the Interior, U. S. Geological Survey, "Surface Water Records of Illinois, 1963."

A. Minimum daily low flow with a one year in 30 recurrence interval considered dependable for water supply purposes.

B. Minimum seven consecutive day low flow with a one year in 10 recurrence interval considered dependable for water quality control purposes.

Table V-2

Surface Water Quality on and near Main Stem of Little Wabash River[1]

Sample Stations[2]		Chloride mg/l	Sulfate mg/l	Total Alkalinity mg/l	Total Hardness mg/l	Specific Conductance micrombos/cm	Dissolved Solids mg/l	Turbidity mg/l	5 day BOD mg/l	pH	D.O. mg/l	Coliform[3] per 100 ml	Bacteria[3] per ml
(A) Little Wabash River													
at Route 141 at	Max	77	60	174	208	660	400	180	4.0	7.8	11.4	1,100	87,000
New Haven	Avg	44	36	98	117	429	246	78	3.0	7.4	6.2	216	42,000
(7 samples 9-58 - 11-64)	Min	14	15	22	48	180	110	45	1.7	6.7	4.0	10	720
(B) Little Wabash River													
raw water intake	Max	255	307	284	292	1,170	710	900	23.0	8.2	18.2	22,000	220,000
at river, Carmi	Avg	71	38	115	155	479	292	128	4.1	7.4	5.0	195	19,800
(99 samples 4-58 - 11-64)	Min	4	5	26	50	150	90	7	0.2	6.7	1.2	10	4
(C) Skillet Fork													
5 miles north	Max	87	85	172	270	980	590	340	8.0	8.1	12.4	104,000	74,000
of Carmi	Avg	50	30	94	136	443	265	128	3.7	7.3	6.3	800	5,650
(10 samples 9-58 - 8-63)	Min	22	8	26	52	190	110	30	1.2	6.7	0.6	10	670
(D) Muddy Creek 12 mi.													
east of Flora,	Max	1,100	88	132	380	3,470	2,080	320	9.0	7.7	10.8	89,000	320,000
Highway 50	Avg	208	45	78	160	863	514	177	5.1	7.1	5.9	1,110	25,300
(7 samples 9-58 - 8-63)	Min	13	21	36	54	160	90	18	2.3	6.6	2.5	10	720
(E) Little Wabash River													
Louisville raw	Max	27	43	214	244	530	320	450	4.8	8.0	12.5	26,000	79,000
water intake	Avg	17	27	114	137	330	201	146	2.6	7.5	6.0	486	12,000
(7 samples 8-58 - 6-63)	Min	7	12	40	54	120	70	40	0.2	6.9	3.0	20	700
(F) Little Wabash River													
north of Effingham	Max	61	75	254	304	600	360	320	6.8	7.9	12.0	17,000	140,000
Route 32 and 33	Avg	17	51	172	216	436	262	102	3.3	7.6	7.6	2,540	15,400
(8 samples 9-58 - 8-63)	Min	7	28	92	124	260	160	11	1.4	6.9	5.2	80	4,200

1. Data from files of Illinois State Department of Public Health, Division of Sanitary Engineering.
2. Sample stations are shown on Figure III. 3. Average values shown are geometric averages, all other average values are arithmetic.

Table V-3

Average Surface Water Quality - Little Wabash River Basin[1]

Location	Temperature °F	pH	Conductivity in micrombos/cm	D.O. mg/1	5 day BOD mg/1	Alkalinity mg/1	Cold Acidity[3] mg/1	Total Hardness mg/1	Chloride mg/1	Turbidity mg/1	NO_3 mg/1	River Mile[4]	Flow[5] cfs
Fox River													
Station 1	68.3	7.6	470	2.5	5.4	56	13	200	64	203	3.1	129	
Station 2	70.8	7.5	950	0	20.4	149	15	230	108	72	2.2	126	
Station 3	70.2	7.6	561	3.9	8.8	66	5	142	84	292	2.8	112	
Confluence with Little Wabash River												109	
Skillet Fork													
Station 11	75.0	7.4	599	3.6	3.7	103	9	215	99	160	1.1	75	3.4
Station 12	73.6	7.3	1,084	5.6	3.0	120	7	254	260	247	0.8	60	
Station 12A[2]	74.7	7.5	1,242	3.4	4.9	173	--	302	271	200	--	52	
Station 13	73.6	7.4	609	3.9	3.6	104	10	184	125	200	2.9	44	
Confluence with Little Wabash River												41	
Little Wabash River													
Station 4	72.3	8.2	539	7.0	4.2	199	9	305	56	120	.3	131	57
Station 5	74.7	8.0	600	5.7	1.7	164	7	251	68	185	1.9	115	
Station 6	73.4	7.8	580	5.5	2.2	155	6	225	63	255	2.2	108	
Station 7	75.3	7.8	604	5.6	1.8	148	6	216	72	225	2.1	100	
Station 8	73.9	7.4	600	5.0	1.8	133	7	189	76	283	2.6	89	
Station 9	74.1	7.5	613	4.4	2.1	158	5	221	95	340	2.8	74	
Station 10	74.8	7.2	518	2.5	3.2	81	7	208	96	260	3.6	43	
Station 14	75.0	7.2	448	2.2	3.6	81	7	142	75	317	3.6	36	
Station 15	75.9	7.3	461	4.5	1.7	72	8	156	87	327	3.8	31	182

1. Daily samples collected by Evansville Field Station, Ohio River Basin Project, 16, 17, 18, 21 through 25 June 1965, except as noted. 2. Daily samples collected only on 23, 24, and 25 June 1965.
3. Analysis of only one sample. 4. Approximate river mile above mouth of Little Wabash River obtained from U. S. Army Corps of Engineers profiles for Little Wabash River and Skillet Fork. Miles for Fox River scaled from U.S.G.S. maps. 5. Average of preliminary discharge measurements at U.S.G.S. gaging stations on sampling dates.

Table V-4

Surface Water Quality in Little Wabash River Basin* at Wayne City and Clay City

	Flow 1/ cfs	Temperature °F	Turbidity mg/l	Fe mg/l	Mn mg/l	SiO_2 mg/l	Chloride mg/l	SO_4 mg/l	NO_3 mg/l	NH_4 mg/l	Ca mg/l	Mg mg/l	Na mg/l	Alkalinity mg/l (as $CaCO_3$)	Total Hardness mg/l	Total Dissolved Solids mg/l
	Little Wabash River - Clay City 2/						3/							Drainage Area - 1,134 Sq. Mi.		
Max.	5,260	86.5	652	13.0	1.2	26.1	385	172.4	18.0	0.6	84.5	36.3	207	232	361	863
Avg.	592	55.9	85	2.7	0.4	10.0	58	60.9	2.8	0.1	44.2	17.0	38	117	180	313
Min.	0.3	32.0	4	0.0	0.0	1.9	9	13.0	0.1	0.0	10.4	3.1	2	32	46	87
	Skillet Fork - Wayne City 2/						4/							Drainage Area - 464 Sq. Mi.		
Max.	7,800	81.0	789	17.7	1.4	37.0	162	254.6	6.3	0.5	95.2	37.1	92	116	391	563
Avg.	605	55.0	114	3.2	0.6	14.2	26	120.6	1.9	0.1	37.7	17.6	25	59	167	289
Min.	1.2	30.0	2	0.2	0.0	6.1	4	21.6	Tr	0.0	10.3	2.8	2	2	38	79

* Illinois State Water Survey Bulletin No. 45, "Quality of Surface Waters in Illinois," Urbana 1957.

1/ Flow values for days of sampling. For flows over the period of record at these sampling points, see Table V-1.

2/ Sample points at U.S.G.S. gaging stations.

3/ Sixty-five samples analyzed at this station between October 1950 and June 1956.

4/ Fifty-four samples analyzed at this station between October 1945 and September 1950.

Table V-5

Mineral Content of Public Ground Water* Supplies in the Little Wabash River Basin

1960 Population Served by Wells	Source**	Treatment***	Fe mg/l	Mn mg/l	NH_4 mg/l	Na mg/l	Ca mg/l	Mg mg/l	SO_2 mg/l	F mg/l	NO_3 mg/l	Cl mg/l	SO_4 mg/l	Alkalinity mg/l (as $CaCO_3$)	Total Hardness mg/l	Total Dissolved Minerals mg/l	pH	CO_2 mg/l	°F
		Coles County - Mattoon (methane present)																	
----	D	ILCl	3.8	Tr	5.9	2	93.6	37.0	22	0.2	1.6	4	58	340	386	440	7.4	34	55.6
		Cumberland County - Neoga																	
----	D	IZCl	1.5	0.2	0.3	89	83.7	23.8	27	0.2	.1	117	46	288	308	547	7.2	51	54.8
		Effingham County - Dietrich																	
590	D	AIZ	2.0	0.2	0.1	73	131.5	55.7	19	0.3	2.1	34	273	384	558	863	---	--	59.0
		Effingham County - Teutopolis (treated)																	
1,050	D	ILCl	1.8	0.1	0.4	39	88.5	29.6	19	0.4	1.0	23	99	292	343	466	---	--	56.0
		Fayette County - Farina																	
----	S	----	0.2	0.1	Tr	61	72.8	28.9	25	0.3	2.4	26	6	390	301	458	---	--	58.5
		Richland County - Noble																	
755	S	I	0.1	Tr	Tr	98	72.8	47.9	26	0.2	1.1	20	68	492	379	619	---	--	---
		Shelby County - Sigel																	
405	D	---	2.7	Tr	0.3	59	49.5	22.6	17	0.5	0.4	17	5	316	217	372	---	--	56.5
		Shelby County - Stewardson																	
600	D	I	0.0	Tr	Tr	36	65.5	23.6	18	0.1	1.2	3	32	300	261	376	---	--	56.5

Table V-5 (Cont'd)

Mineral Content of Public Ground Water* Supplies in the Little Wabash River Basin

1960 Population Served by Wells	Source**	Treatment***	Fe mg/l	Mn mg/l	NH_4 mg/l	Na mg/l	Ca mg/l	Mg mg/l	SO_2 mg/l	F mg/l	NO_3 mg/l	Cl mg/l	SO_4 mg/l	Alkalinity mg/l (as $CaCO_3$)	Total Hardness mg/l	Total Dissolved Minerals mg/l	pH	CO_2 mg/l	°F
	Wayne County - Middleton																		
560	D	IA	1.6	0.0	1.3	12	62.9	24.8	31	0.0	0.4	8	1	276	260	294	7.4	28	55.6
	White County - Crossville (treated)																		
875	D	IZ	0.3	0.2	Tr	6	98.8	29.7	14	0.4	1.5	28	33	308	369	407	---	--	59.0
	White County - Enfield																		
850	S	--	0.6	0.0	0.8	487	23.5	14.5	12	3.0	1.6	144	161	808	127	1,330	8.0	20	59.6
	White County - New Haven																		
800	D	ZCI	2.6	0.3	Tr	6	82.3	25.1	24	0.1	0.4	4	32	284	309	335	7.2	--	---

* Illinois State Water Survey Circular 90, "Mineral Content of Public Ground-Water Supplies in Illinois," Urbana 1963.

** Source: D = Unconsolidated materials above bedrock
L = Limestone deposits
S = Sandstone deposits

*** Treatment: I = Iron removal
A = Aeration
L = Lime or lime-soda softening
Z = Zeolite (or ion-exchange) softening
Cl = Chlorination
F = Fluoridation

Table VI-1

Little Wabash River Basin Study
Employment

	1950	1960	1980	2020
Agriculture	18,500	11,300	5,400	4,000
Mining	5,600	4,300	2,400	900
Construction	3,900	2,800	6,600	11,000
Transportation & Util.	4,000	4,000	6,000	11,000
Wholesale-Retail Trade	9,900	10,600	13,400	22,000
Finance, Ins. & R.E.	900	1,300	2,600	4,700
Services	8,100	9,900	18,600	40,000
Government	1,600	1,900	4,200	11,000
Nonclassified	1,000	1,000	600	200
Manufacturing	7,740	9,610	13,200	24,000
Total Employment	61,240	56,710	73,000	128,800

Source: Projections were made from a special study conducted by the Louisville District Office of the U. S. Army Corps of Engineers.

Table VI-2

Number and Employment Size of Manufacturing Plants
Little Wabash River Basin Study
(Clay, Cumberland, Edwards, Effingham, Hamilton, Jasper, Lawrence, Richland, Wabash, Wayne, White Counties, Illinois)

	1-19*	20-49	50-99	100-249	250-499	500-999	1,000-Over	Total
Food & Kindred Products	22	4	1					27
Tobacco Products								
Textile Mill Products					1			1
Apparel & Related Products	8			5	2			15
Lumber & Wood Products	27			1				28
Furniture & Fixtures	2		1					3
Paper & Allied Products	2		1					3
Printing & Allied Products	27							27
Chemicals & Allied Products	1	1						2
Petroleum & Coal	5		1		1			7
Rubber & Plastic		1		1				2
Leather Products	1			1	3			5
Stone, Clay, Glass	11							11
Primary Metals	1							1
Fabricated Metals	2				1			3
Non-Electrical Machinery	9	1	3	2				15
Electrical Machinery	1			1			1	3
Transportation Equipment	3			1	1			5
Instruments	1							1
Miscellaneous	3	2		1				6
Total	126	9	7	13	9		1	165

*1-19 - Plants from the 1958 Census of Manufactures; others from McGraw-Hill Survey.

Source: Location of Manufacturing Plants by County, Industry, and Employment Size, Census of Manufacturing, 1958, Bureau of the Census, U. S. Department of Commerce, McGraw-Hill Survey of Industrial Plants, 1964.

Table VI-3

Little Wabash River Basin Study
Index of Output of Specific Commodities
1960=100*

S.I.C.		Output (000)	1960	Output (000)	1980	Output (000)	2020
20	Food & Kindred Products	28,500	100	46,800	160	100,000	350
23	Apparel & Related Products	17,300	100	22,000	125	11,000	60
24	Lumber & Wood Products	8,400	100	21,500	250	58,600	700
29	Petroleum Refining	20,000	100	28,800	140	42,800	200
31	Leather & Leather Prod.	8,500	100	12,800	150	17,000	200
34	Fabricated Metals	9,500	100	9,000	90	15,700	170
36	Electrical Machinery	37,000	100	146,000	400	579,000	1,600
37	Transportation Equipment	1,400	100	2,500	200	7,400	500

Source: Computed from the Projective Economic Study of the Ohio River Basin, Arthur D. Little Company, Inc.
*Output in constant 1960 dollars.

Table VI-4

Little Wabash River Basin Study
Population

County	1950	1960	1980	2020
Clay	17,445	15,815	18,000	34,000
Louisville Twp.	1,777	1,681	2,500	5,000
Harter Twp. (Flora)	6,978	6,925	9,000	19,000
Coles	40,328	42,860	50,000	90,000
Mattoon Twp.	17,906	19,138	27,000	60,000
Cumberland	10,500	9,936	11,000	16,000
Neoga Twp.	2,176	2,129	3,000	6,500
Edwards	9,056	7,940	9,000	15,000
Albion Twp.	3,197	2,833	4,500	7,500
Effingham	21,675	23,109	27,000	50,000
Douglas Twp.	8,877	10,096	15,000	24,000
Mound Twp.	2,349	2,421	3,500	7,000
Teutopolis Twp.	1,197	1,534	3,000	6,000
Hamilton	12,256	10,010	11,500	20,000
McLeansboro Twp.	4,251	4,081	5,500	9,000
Jasper	12,266	11,346	12,500	19,000
Lawrence	20,539	18,540	20,000	31,000
Richland	16,889	16,299	19,000	36,000
Olney Twp.	9,655	9,962	13,000	20,000
Wabash	14,651	14,047	16,000	29,000
Wayne	20,933	19,008	21,000	36,500
Fairfield Area (Big Mound, Grover, Jasper, and Lamord Twps.)	9,151	9,370	12,000	21,000
Orel Twp.	1,464	1,446	2,000	4,500
White	20,935	19,373	22,500	41,000
Carmi and Hawthorne Twps.	8,067	8,739	12,000	25,000
Total Study Area	217,473	208,213	237,500	417,500

Source: Historical Data from the U. S. Census of Population 1950, 1960, Bureau of the Census, U. S. Department of Commerce. Projections based on a special study made by the Louisville District Office of the Corps of Engineers.

Table VI-5

1960 Urban and Total Population by County in the Economic Study Area of the Little Wabash River Basin*

County	Urban Pop.	Total Pop.	
Clay	5,331	15,815	
Coles[1]	29,593	42,860	
Cumberland	--	9,936	
Edwards	--	7,940	
Effingham	8,172	23,107	
Hamilton	2,951	10,010	
Jasper[2]	2,901	11,346	
Lawrence[3]	5,492	18,540	
Richland	8,780	16,299	
Wabash[3]	8,594	14,047	
Wayne	6,362	19,008	
White	6,152	19,373	
Totals	84,328	208,281	(56,836)[4]

*Urban population defined by the U. S. Bureau of the Census related to this report as incorporated places with 2,500 inhabitants or more. U. S. Department of Commerce, Bureau of the Census, 1960 Census of Population, Vol. 1, Part A.

1. Of this total urban population, 10,505 not in the engineering study area.
2. This 2,901 urban population not in the engineering study area.
3. These counties not in the engineering study area.
4. Total urban population in the engineering study area.

Table VII-1

Present Surface Water Supplies in the Little Wabash River Basin*

Community	1962 Pop. Served	Source of Supply	Average Water Use (mgd)	Average Water Use (gpcd)	Maximum Water Use (mgd)	Maximum Water Use (gpcd)
Altamont	1,500	Impoundment on Second Cr.	0.138	83	0.189	126
Carmi	6,500	Impoundment on Little Wabash River	0.750	115	1.34	206
Clay City	1,145	Little Wabash River	0.070	61	0.15	131
Effingham	9,880	Little Wabash River and Lake Sara	1.0	102	1.5	153
Fairfield	6,600	Impoundment on Little Wabash River	1.0	151	1.3	197
Flora	5,365	Impoundment on Little Wabash River	0.555	103	1.0	186
Louisville	910	Impoundment on Little Wabash River	0.1	110	0.12	132
McLeansboro[1]	3,000	Impoundment on branch of Big Creek	0.230	77	----	---
Mattoon	25,000	Lake Paradise and Lake Mattoon	2.25	90	3.00	120
Neoga	1,140	Lake Mattoon	0.072	63	----	---
Olney	7,200[2]	Vernor Lake, New Olney Lake and Impoundment on Fox River	1.5	208	1.8	250
Wayne City	940	Impoundment on Skillet Fk.	0.070	74	0.120	128
Xenia	445	From Flora	0.013	29	0.020	45

* See reference 23 in Bibliography.
1. Note all use figures are for 1965 except McLeansboro for which 1962 figures were used.
2. This is 1965 estimate of population served.

Table VII-2

Present Ground Water Supplies in the Little Wabash River Basin*

Community	1962 Pop. Served	Source of Supply	Average Water Use (mgd)	Average Water Use (gpcd)	Maximum Water Use (mgd)	Maximum Water Use (gpcd)
Albion	1,975	Wells near Grayville in Wabash River Basin	0.200	101	0.220	111
Calhoun	250	Drilled wells	0.007	28	----	---
Cisne	610	Rock well	0.050	82	0.060	98
Crossville	875	2 wells	0.065	74	0.10	114
Dietrich	590	3 drift wells	0.021	36	----	---
Edgewood[1]	450	Drilled wells	0.025	32	0.050	65
Enfield	850	3 rock wells	0.040	47	0.060	71
Mason	320	From Edgewood	0.010	31	----	---
New Haven	800	4 drift wells	0.040	50	----	---
Noble	755	3 rock wells	0.050	66	0.075	99
Parkersburg	250	Drilled wells	0.0048	19	0.010	40
Sigel	405	Drift wells	0.011	27	----	---
Teutopolis	1,050	2 wells	0.057	54	0.070	67

* "1963 Inventory Municipal Water Facilities," U. S. Department of Health, Education, and Welfare, Public Health Service Publication No. 775 (revised), Vol. 5, a cooperative State-Federal report; and supplemental information from letters and trips in the study area.

1. Water use based on combined population of Edgewood and Mason.

Table VII-3

Present and Projected Average Water Use of the
Surface Water Supplied Communities in the Little Wabash River Basin

Community	1960 Pop. Served	1960 gpcd	1960 mgd	1980 Pop. Served	1980 gpcd	1980 mgd	2020 Pop. Served	2020 gpcd	2020 mgd
Altamont	1,500	83	0.138	2,275	100	0.23	5,950	120	0.71
Carmi	6,500	115	0.750	9,600	140	1.34	22,500	170	3.83
Clay City	1,145	61	0.070	1,400	80	0.11	2,850	100	0.29
Effingham	9,880	102	1.0	15,000	130	1.95	24,000	170	4.08
Fairfield	6,600	151	1.0	9,000	170	1.53	17,850	180	3.21
Flora	5,365	103	0.555	7,200	130	0.94	17,100	170	2.91
Louisville	910	110	0.1	1,500	120	0.18	3,500	160	0.56
McLeansboro	3,000	77	0.230	4,125	100	0.41	7,650	120	0.92
Mattoon	25,000	90	2.25	35,750	120	4.29	79,200	160	12.7
Neoga	1,140	63	0.072	1,800	80	0.14	4,550	100	0.46
Olney	7,200	208	1.5	10,400	200	2.08	18,000	190	3.42
Wayne City	940	74	0.070	1,400	90	0.13	3,375	110	0.37
Xenia	445	29	0.013	550	60	0.03	1,120	75	0.08
		Totals	7.75			13.36			33.54

Table VII-4

Present and Projected Average Water Use of the
Ground Water Supplied Communities in the Little Wabash River Basin

Community	1960 Pop. Served	1960 gpcd	1960 mgd	1980 Pop. Served	1980 gpcd	1980 mgd	2020 Pop. Served	2020 gpcd	2020 mgd
Albion	1,975	101	0.200	3,400	100	0.34	6,400	110	0.70
Calhoun & Parkersburg	500	24	0.012	540	60	0.03	640	80	0.05
Cisne	610	82	0.050	950	90	0.09	1,410	110	0.16
Crossville	875	74	0.065	1,720	90	0.15	4,500	110	0.50
Dietrich	590	36	0.021	640	60	0.04	815	80	0.07
Edgewood & Mason	770	32	0.025	860	60	0.05	1,050	80	0.08
Enfield	850	47	0.040	1,060	60	0.06	1,570	80	0.13
New Haven	800	50	0.040	850	80	0.07	950	100	0.10
Noble	755	66	0.050	945	80	0.08	980	100	0.10
Sigel	405	27	0.011	460	60	0.03	830	80	0.07
Teutopolis	1,050	54	0.057	2,250	90	0.20	5,100	110	0.56
		Totals	0.57			1.14			2.52

Table VIII-1

Little Wabash River Basin Municipal Waste Treatment Plants[1]

Community	1960 Pop.	1962 Pop. Served	P.E. Untreated	P.E. Discharged	Percent Removed	Treatment	Receiving Stream
Albion	2,025	2,100	2,100 E	315 E	85	Secondary	Butter Creek
Altamont	1,656	800	800 E	120 E	85	Secondary	Branch of Big Creek
Carmi	6,152	3,000	3,000 E	450 E	85	Secondary	Little Wabash River
Cisne	615	900	900 E	135 E	85	Secondary	Deer Creek
Clay City	1,144	700	700 E	105 E	85	Secondary	Little Wabash River
Crossville	874	800	800 E	120 E	85	Secondary	Little Wabash River
Effingham	8,172	8,170	8,170 E	1,225 E	85	Secondary	Mud Cr. to Salt Cr.
Enfield	791	350	350 E	---	--	2 Oxidation Ponds	Skillet Fork
Fairfield	6,362	6,700	6,700 E	1,005 E	85	Secondary	Pond Creek
Flora	5,331	6,300	3.320	220	93	Secondary	Seminary Creek
Louisville	906	905	905	135 E	85	Oxidation Pond	Little Wabash River
*McLeansboro	2,951	2,500	2,500 E	375 E	85	Secondary	Discharge into Saline Rv. Ba.
*Mattoon	19,088	18,000	18,000 E	2,700 E	85	Secondary	Discharges into Embarrass Rv. Ba. except storm water overflow discharged to Little Wabash Rv.
Neoga	1,145	1,145	1,145 E	170 E	85	Secondary	Little Wabash River
Noble	761	760	760	115 E	85	Oxidation Pond	Little Wabash River
Olney	8,780	7,900	29,200	3,140	89	Secondary	Fox River
Teutopolis	1,140	1,100	1,100 E	165 E	85	Secondary	Little Wabash River
Wayne City	903	905	905	135 E	85	2 Oxidation Ponds	Skillet Fork

* Discharge outside of the Little Wabash River Basin.

1. Values obtained from "1962 Inventory Municipal Waste Facilities," U. S. Department of Health, Education, and Welfare, Public Health Service Publication No. 1065, Vol. 5.

E = Estimated values.

Table VIII-2

Anticipated Treated Municipal and Industrial Waste Discharges
Effluent Loadings of Little Wabash River Basin

Community	Effluent Loadings in P.E. 1980	2020
Albion	810	1,430
Altamont	390	1,060
Carmi	1,350	4,220
Cisne	260	410
Clay City	230	560
Crossville	260	530
Effingham	2,870	4,860
Enfield	150	270
Fairfield	2,030	4,020
Flora	1,890	4,060
Louisville	340	840
McLeansboro*	790	1,520
Mattoon*	6,000	14,600
Neoga	410	1,100
Noble	180	240
Olney	7,100	8,640
Teutopolis	510	1,150
Wayne City	320	810

* Wastes discharged outside the basin.

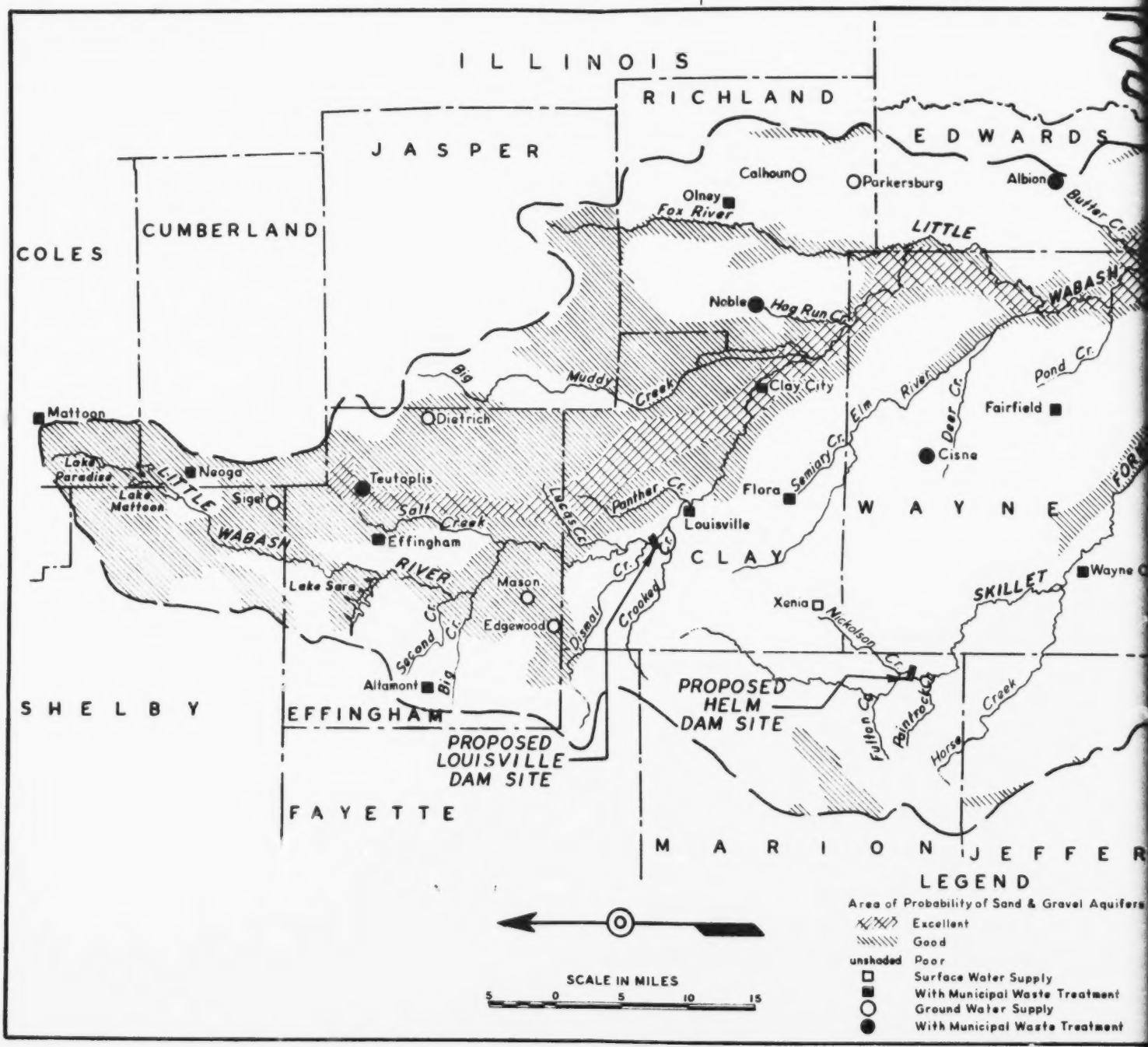
Table VIII-3

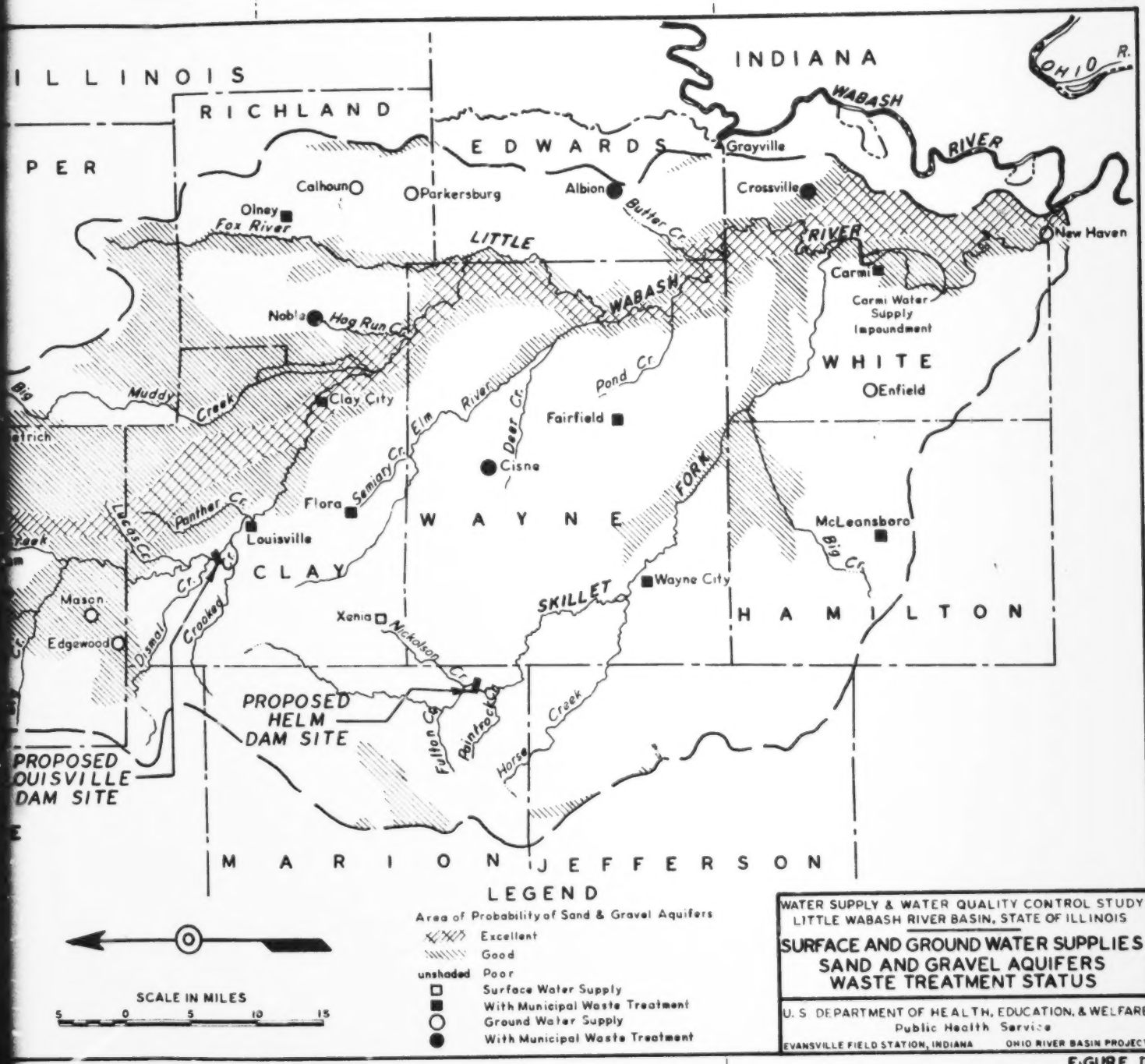
Anticipated Storage Need* for Water Quality Control
Based on Alternative 1 for Various Levels of Protection
Little Wabash River Basin

Point of Need	1980 Recurrence Interval (Years) 5	10	20	2020 Recurrence Interval (Years) 5	10	20
Wayne City	550	970	1,400	2,600	3,200	4,000
Fairfield (Pond Creek)	2,000	3,200	4,000	5,700	9,000	10,000
Carmi	840	1,000	1,300	8,000	11,000	14,000

* All needs expressed as acre-feet of draft-on-storage and do not include evaporation and transmission losses.

A-20. A


ILLINOIS
RICHLAND
EDWARDS
JASPER
CUMBERLAND
COLES
Calhoun
Parkersburg
Albion
Olney
Fox River
Butler Cr.
LITTLE
WABASH
Noble
Hog Run Cr.
Big
Muddy
Creek
Clay City
Pond Cr.
Elm River
Deer Cr.
Fairfield
Mattoon
Dietrich
Lake Paradise
Neoga
Lake Mattoon
Sigel
Teutoplis
Salt Creek
Lucas Cr.
Panther Cr.
Flora
Semiary Cr.
Cisne
WAYNE
Louisville
Effingham
CLAY
Wayne
Lake Sara
Mason
Edgewood
Dismal Cr.
Crooked Cr.
SKILLET
Xenia
Nickolson Cr.
Second Cr.
Big
Altamont
SHELBY
EFFINGHAM
PROPOSED HELM DAM SITE
Fulton Cr.
Paintrock
Horse Creek
PROPOSED LOUISVILLE DAM SITE
FAYETTE
MARION
JEFFER
LEGEND
Area of Probability of Sand & Gravel Aquifers
Excellent
Good
unshaded Poor
Surface Water Supply
With Municipal Waste Treatment
Ground Water Supply
With Municipal Waste Treatment
SCALE IN MILES
5 0 5 10 15



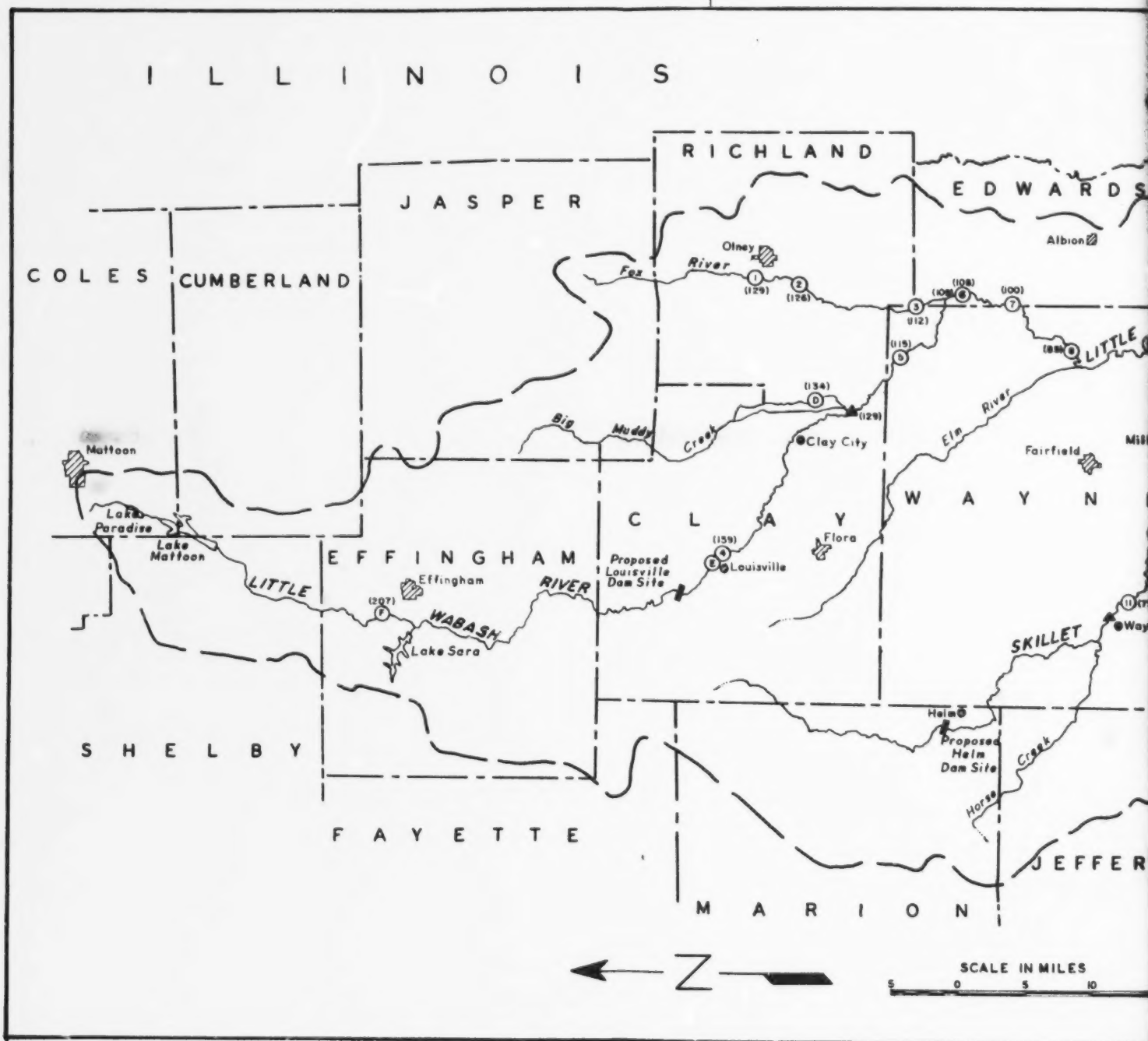
WATER SUPPLY & WATER QUALITY CONTROL STUDY
LITTLE WABASH RIVER BASIN, STATE OF ILLINOIS

SURFACE AND GROUND WATER SUPPLIES SAND AND GRAVEL AQUIFERS WASTE TREATMENT STATUS

U. S DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
Public Health Service
EVANSVILLE FIELD STATION, INDIANA — OHIO RIVER BASIN PROJECT

FIGURE II

A-21-a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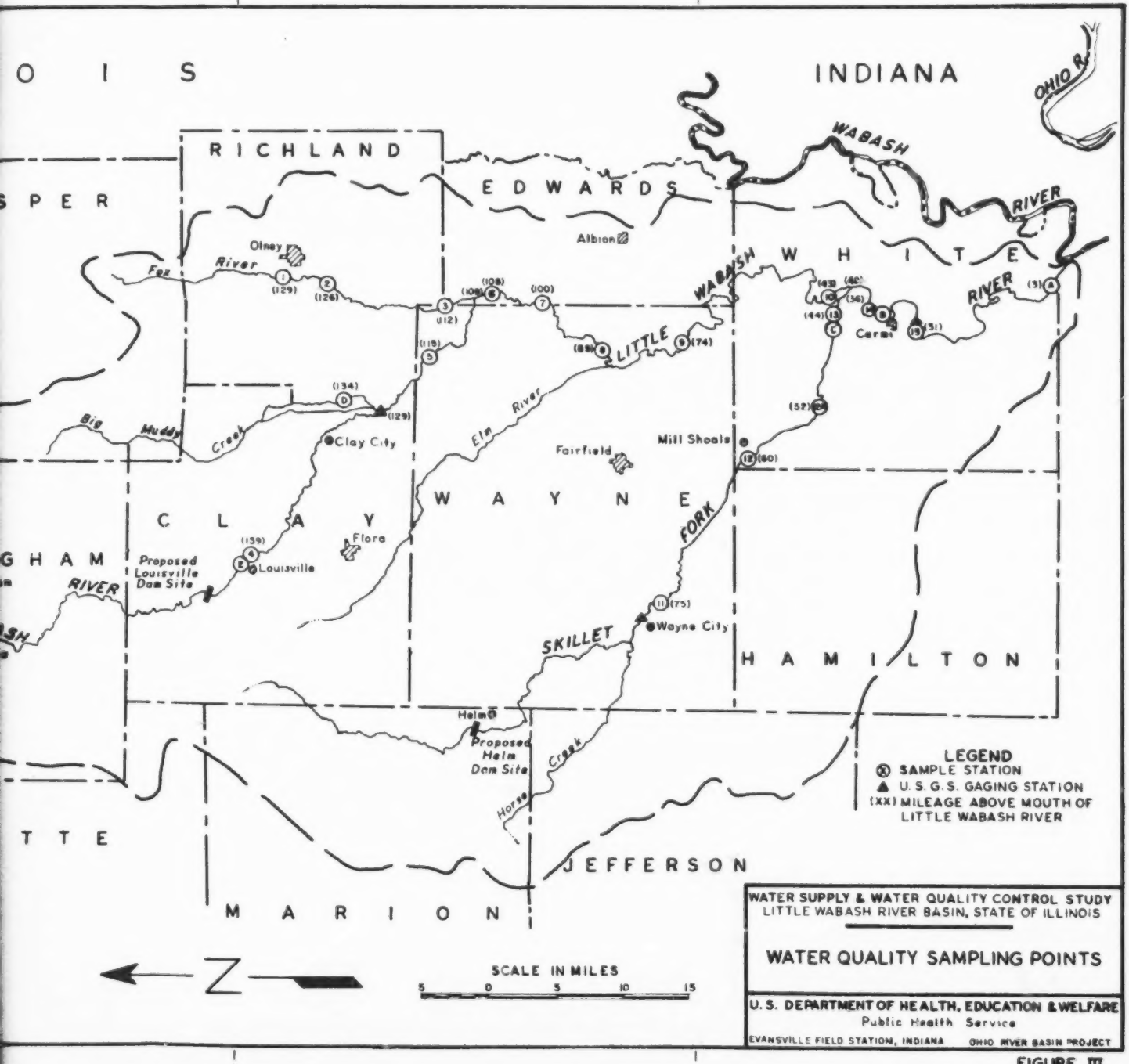
RICHLAND
EDWARDS
JASPER
COLES
CUMBERLAND
Olney
Albion
Fox River
Mattoon
Lake Paradise
Lake Mattoon
Big Muddy Creek
Clay City
Elm River
Fairfield
CLAY
WAYNE
Flora
Louisville
Proposed Louisville Dam Site
EFFINGHAM
Effingham
LITTLE WABASH RIVER
Lake Sara
SKILLET
Helm
Proposed Helm Dam Site
Horse Creek
SHELBY
FAYETTE
MARION
JEFFER
N
SCALE IN MILES
5 0 5 10



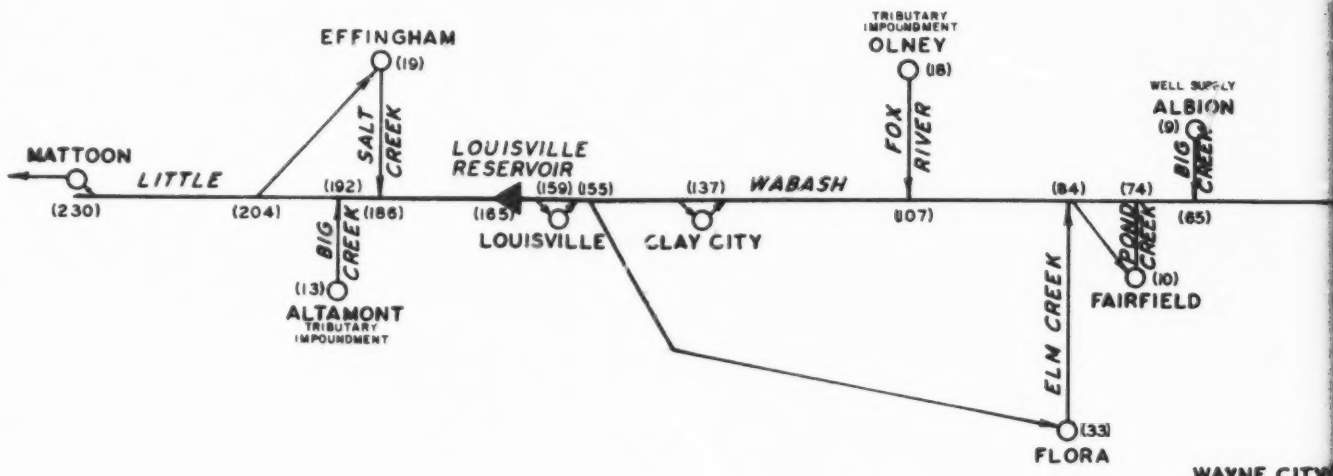
WATER SUPPLY & WATER QUALITY CONTROL STUDY
LITTLE WABASH RIVER BASIN, STATE OF ILLINOIS

WATER QUALITY SAMPLING POINTS

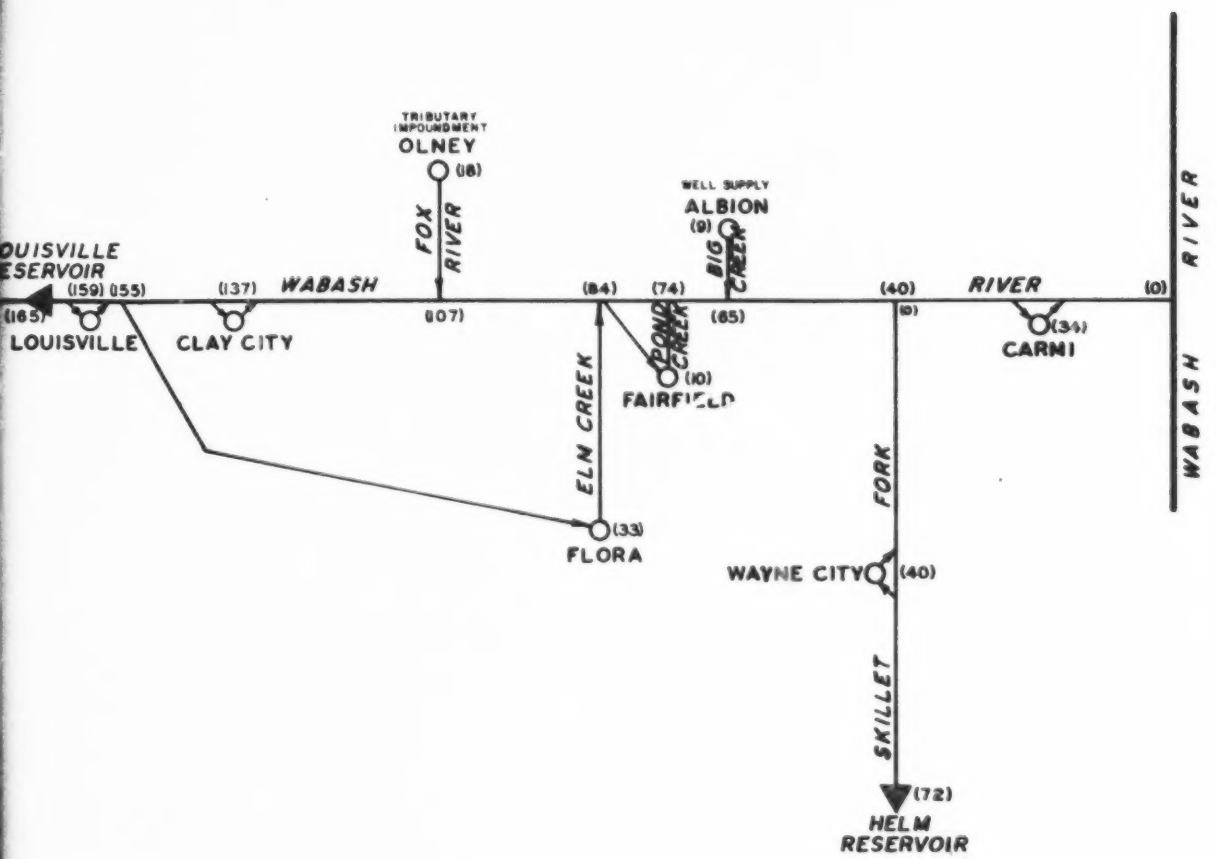
U. S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
Public Health Service
EVANSVILLE FIELD STATION, INDIANA OHIO RIVER BASIN PROJECT

FIGURE III

A-22-a



NOTE:
RIVER MILES SHOWN IN PARE



NOTE:
RIVER MILES SHOWN IN PARENTHSIS.

WATER SUPPLY & WATER QUALITY CONTROL STUDY
LITTLE WABASH RIVER BASIN—STATE OF ILLINOIS

WATER SUPPLY & WASTE DISCHARGE SCHEMATIC

U. S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
Public Health Service
EVANSVILLE FIELD STATION, INDIANA OHIO RIVER BASIN PROJECT

FIGURE IV

LITTLE WABASH RIVER
MONTHLY FLOW EXPRESSED AS % OF ANNUAL FLOW FOR LOWEST 25% OF YEARS OF RECORD AT CARMI

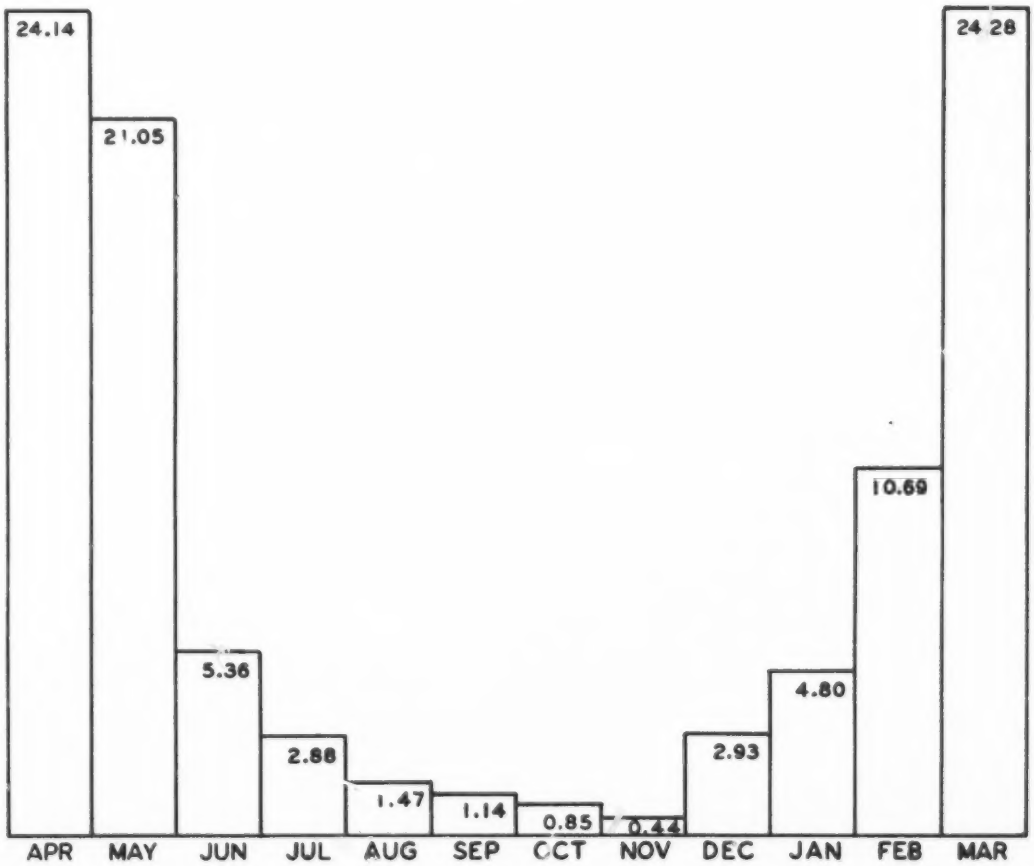


FIGURE V

SKILLET FORK
MONTHLY FLOW EXPRESSED AS % OF ANNUAL FLOW FOR LOWEST 25% OF YEARS OF RECORD AT WAYNE CITY

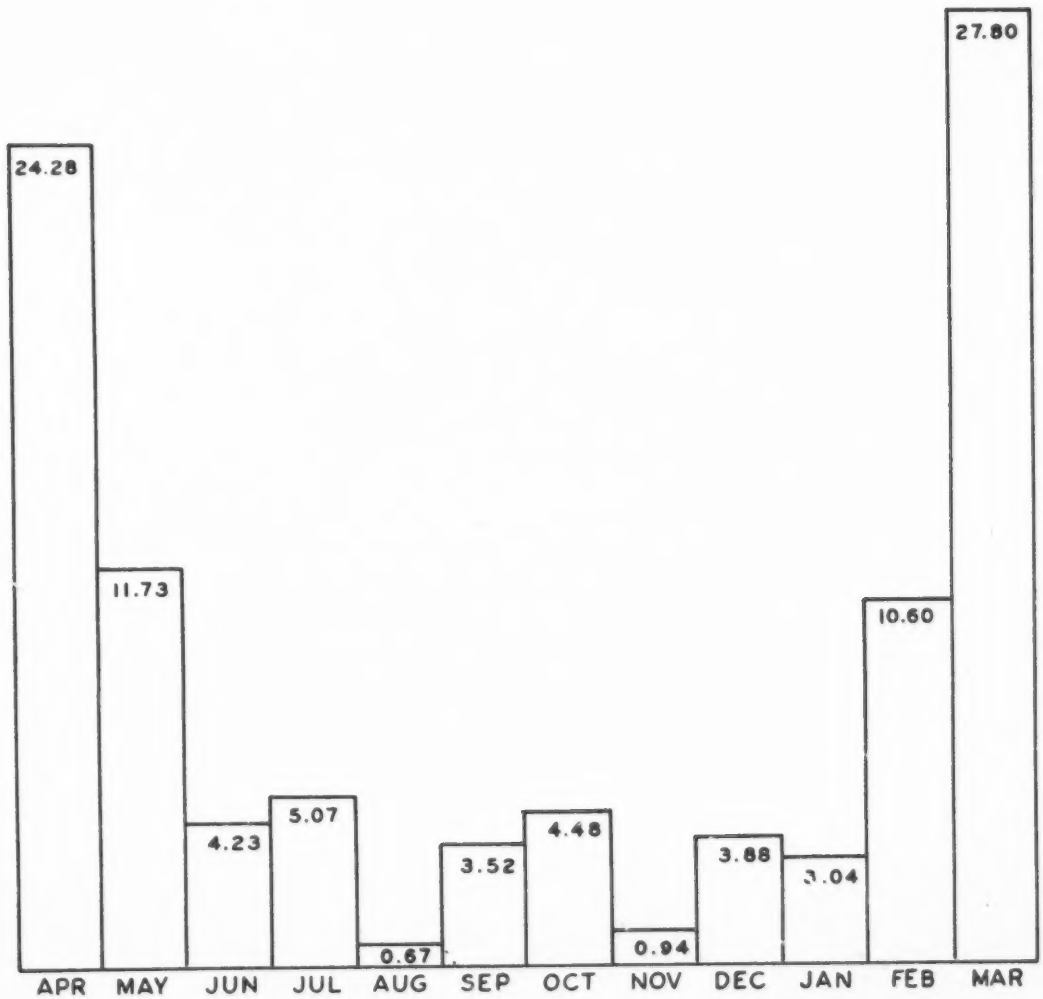


FIGURE VI

LITTLE WABASH RIVER
MONTHLY FLOW EXPRESSED AS % OF ANNUAL FLOW
FOR
LOWEST 25% OF YEARS OF RECORD AT CLAY CITY

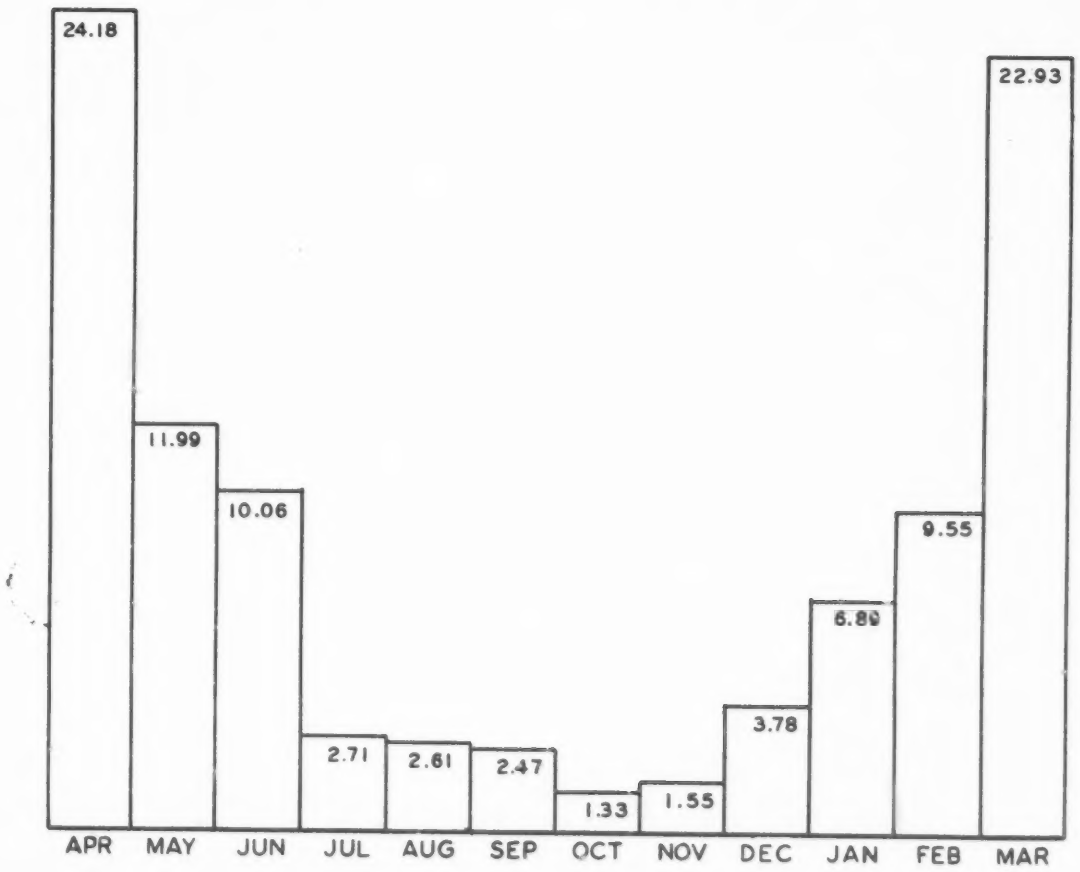
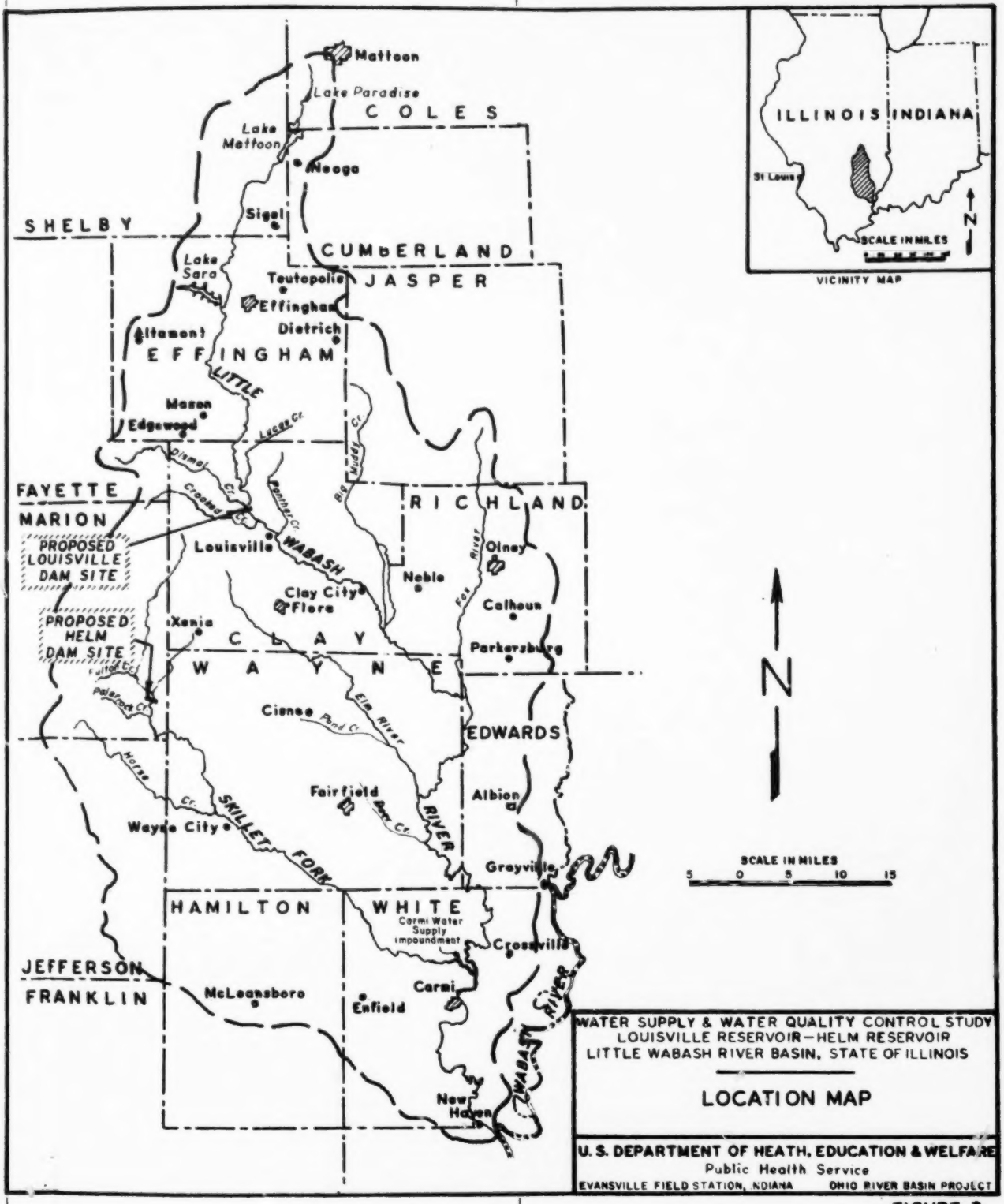


FIGURE VII



WATER SUPPLY & WATER QUALITY CONTROL STUDY
LOUISVILLE RESERVOIR—HELM RESERVOIR
LITTLE WABASH RIVER BASIN, STATE OF ILLINOIS

LOCATION MAP

U. S. DEPARTMENT OF HEATH, EDUCATION & WELFARE
Public Health Service
EVANSVILLE FIELD STATION, INDIANA OHIO RIVER BASIN PROJECT

FIGURE I